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A SYSTEM OF

PRACTICAL SURGERY.

BY

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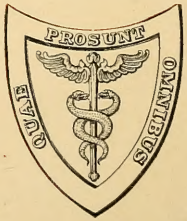
SURGERY OF THE ALIMENTARY TRACT.



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MALFORMATIONS, INJURIES, AND DISEASES OF THE ŒSOPHAGUS.

By Prof. Dr. V. v. HACKER and Dr. G. LOTHEISSEN.

CHAPTER I.

METHODS OF EXAMINING THE ŒSOPHAGUS.

By Prof. Dr. V. v. HACKER.

ŒSOPHAGOSCOPY AND ITS TECHNIC.

By the method now generally employed, which was devised by Mikulicz, the œsophagus is directly inspected by means of a straight tube. This is the simplest and safest form of œsophagoscope. Jointed tubes that can be subsequently straightened were first described for this purpose by Störk, Kelling, and others.[1] In order to direct the light from an electric lamp into the tube, either a panelectroscope (Leiter's) or Casper's electroscope is employed.[2] Either of them can be attached to any tube. For illumination, either a plunge or storage battery or the street or house current is employed. The œsophagus tubes are constructed of sections of metal tubing 10–15 cm. in diameter and 19, 30, 40, 45, or 50 cm. in length. The ends are cut either square or oblique, allowing for a few centimetres to project from the mouth for the purpose of more conveniently handling the tubes. These are the proper lengths for examining those portions of the œsophagus most frequently diseased; namely, the beginning of the œsophagus and its termination, situated respectively about 15 and 40 cm. from the teeth. The region of the bifurcation is about 26 cm. from the teeth. The point where the œsophagus passes through the diaphragm is 37 cm. from the teeth. If the panelectroscope is screwed to the tube and the patient is quiet, both hands will be free, though ordinarily a second person is necessary to prepare and hand the necessary instruments—cotton-carriers, extraction-forceps, etc. The tube is passed by means of a hard-rubber sound obliquely rounded at

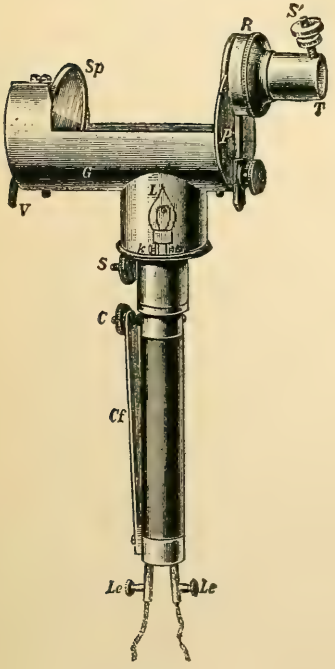
[1] In Mikulicz's clinic, according to Göttstein, it was possible in several rare cases to insert Kelling's tube where the straight tube failed.

[2] The author described Leiter's panelectroscope, together with the most important instrumentarium, in his article, "The Technic of Œsophagoscopy." Casper's electroscope, together with the instrumentarium employed by Mikulicz, is described by v. Hacker, "Technik der Œsophagoskopie," *Wien. klin. Wochenschrift*, 1896; Göttstein, "Technik und klinik der Œsophagoskopie," *Mittheil. aus den Grenzgebrieten der Med. u. Chir.*, 1900–1901, Bd. vi. u. viii.

its tip. Only in particularly difficult cases is the tube passed over an English woven bougie, which exactly fits the tube and is previously passed into the œsophagus. Drawing the larynx away from the vertebral column is only necessary in very exceptional cases. (Figs. 1 and 2.)

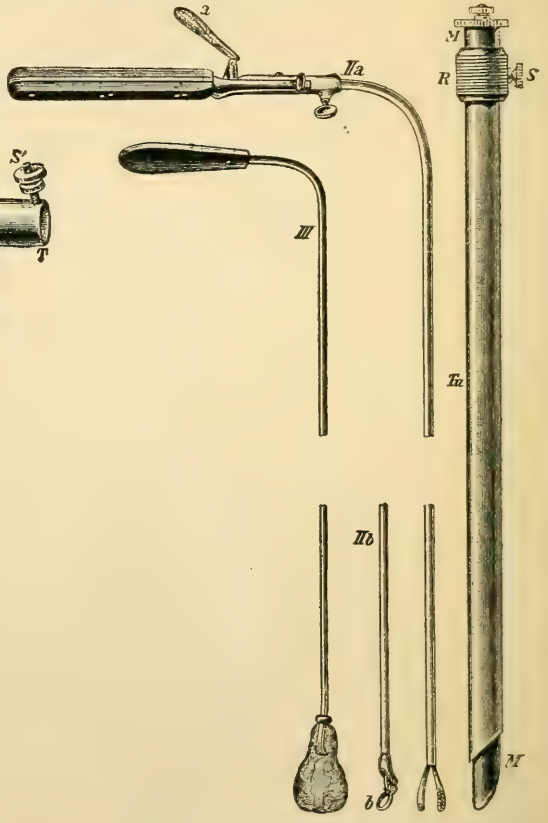
In the following paragraphs the method of œsophagoscopic examination as practised by the author will be described. The patient should be examined with the stomach entirely empty, or at least he should not have eaten anything for some time. If as a result of

FIG. 1.



Œsophagoscope. (Leiter.)

FIG. 2.



Tube, traction-forceps, cotton-carrier, jointed curette.

vomiting, particularly where the tube comes in contact with the cardia, the stomach contents flow into the tube, the latter is lowered (or the foot of the table occupied by the patient is carefully raised). The contents will then flow out; the portion remaining in the tube should be mopped out with cotton or removed by a pump (clysopompes). During the examination the upper part of the body of the patient should be clothed with only a shirt, and the clothes over the lower portion should be opened sufficiently to allow free respira-

tion. Exceptionally, œsophagoscopy may be performed under complete anæsthesia, carefully watching respiration, however. In ordinary cases it is sufficient to paint the pharynx (especially the region of the pyriform sinus) with a 20 per cent. solution of cocaine. The instrument should be lubricated only near its tip with a small quantity of vaselin, water, or egg-albumin. The patient is placed upon the examining-table in a sitting posture. The base of the tongue being gently drawn forward and downward with the left hand, the instrument is now passed, the oblique surface of the tip being directed posteriorly, and the tube made to glide along the posterior pharyngeal wall. If the tube overcomes the normal resistance caused by the larynx pressing against the vertebral column and the contraction of the inferior pharyngeal constrictor, it usually glides down unhindered. Having completed this step, the patient is carefully placed upon his back and inspection begun. In exceptional cases it is easier to pass the instrument with the patient placed upon his back, with head dependent.[1] As far as the cardia no marked muscular resistance is encountered, provided the instrument maintains the same direction. If the instrument becomes caught or if the tube refuses to advance farther, the author immediately employs the panelectroscope or Casper's electroscope in order to place the tube in the centre of the lumen of the œsophagus. In this way it can readily be determined in what direction the tube or the head of the patient must be moved in order to advance the former. This rule is particularly important in advanced carcinoma, ulcerative processes, and internal injuries, in order to avoid perforation with the tube. Such hindrances are explained by the anatomical course of the œsophagus. It should be noted particularly that in the lower portion of the thorax the œsophagus is situated toward the right and posteriorly, but that as soon as it passes through the diaphragm it turns forward and to the left.

Œsophagoscopy should always be preceded by careful examination with graduated bougies, or in case of foreign bodies with a bougie a boule, in order to discover the seat of the disease and to be able to choose the proper length of tube. If the examination is negative, the longest tube should be inserted in order to reach the cardia, and on withdrawing the tube every part of the œsophagus should be illuminated successively.

Œsophagoscopic examination is as a rule readily accomplished. In order to relieve the unpleasant sensation accompanying swallowing, which is occasionally perceived after examination, cracked ice and moist compresses about the throat may be employed.

Œsophagoscopy is contraindicated in acute inflammation of the œsophagus (unless the indication for the removal of a foreign body is more urgent), as well as in all general or local diseases which are associated with serious respiratory disturbances (empyema, certain cardiac diseases, aneurism, tracheal stenosis, etc.) or which furnish any contraindications for the passage of instruments in general.

[1] Mikulicz conducts his examinations in the right lateral position. At his clinic cocainization is carried out under control of the laryngeal mirror.

RADIOSCOPY, PERCUSSION, AND AUSCULTATION OF THE ŒSOPHAGUS.

Radioscopy, either the examination with the fluoroscope or *x*-ray photography, may in certain cases be of diagnostic value and an aid to treatment. Its employment will be considered when treating of foreign bodies, strictures, dilatation, and diverticula of the œsophagus.

Percussion, as well as auscultation, is of subsidiary importance in the diagnosis of diseases of the œsophagus. In case of diverticulum in the neck, if the latter is filled with gas, percussion will produce a tympanitic note; if filled with food, a dull note. Moreover, dilatation of the lower thoracic portion of the œsophagus above the hiatus, if filled with food, and also extensive tumors of this portion, will produce a dull note, sharply demarcated from the clear pulmonary resonance. This is obtained on the left side, at the side of the vertebral column, between the seventh and ninth ribs. (Rosenheim.)

By means of *auscultation* two swallowing-sounds can be perceived: The first, at the beginning of swallowing, which is rarely audible, the so-called *Durchspritzgeräusch*, possesses no diagnostic value. It is caused by the fact that during the normal act of swallowing the air within the closed space of the pharynx is compressed, and thus drives the fluid and soft portions of food through the œsophageal tract, forcing them at the same time as far as the region of the cardia, the latter being under normal circumstances closed. At the moment when the contents are propelled forward by peristalsis and the cardia opens, the second sound is produced (by the accompanying compressed air). This second sound, which can generally be heard, is the so-called *Durchpressgeräusch*. (Meltzer.) It can be heard as a distant gurgling in the upper portion of the left costal border, usually about seven seconds after swallowing. The Durchpressgeräusch is absent in those rare cases in which the first sound is audible. It is absent also when there is marked narrowing near or at the cardia. In the latter cases it is of diagnostic importance even if the Durchspritzgeräusch is not present.

EXAMINATION OF THE ŒSOPHAGUS WITH BOUGIES.

In sounding the œsophagus it is important to note that even under normal conditions the œsophagus possesses three constrictions (v. Hacker): the superior isthmus is situated at the commencement of the œsophagus; the inferior, in the region of the hiatus œsophageus (œsophageal opening in the diaphragm) (frequently 1 or 2 cm. above); the middle one corresponds to the region of the bifurcation of the trachea or the transition of the cervical into the thoracic portion. Between the middle portion and the inferior extremity is situated the widest portion of the organ, which is usually spindle-shaped. It is important to know the total length of the œsophagus, as well as the distance of its most important portions from the teeth, particularly in determining the site of strictures and foreign bodies.

Examination of the œsophagus with bougies frequently takes the place of inspection and manual palpation. Both of the latter measures are only valuable in the cervical portion, in cases of pulsating diverticula and carcinoma, in so far as during the swallowing of food diverticula occasionally produce a diffuse swelling above the clavicle, which may disappear again as soon as the former are emptied by pressure with the hand, and in so far as a carcinoma or secondary glandular enlargement due to the latter may cause a prominence of the neck at the side of the larynx.

Examination with the bougie or stomach-tube should be slowly and carefully conducted. Only in this way is it possible, particularly where disease is present, to follow the irregular course of the œsophagus without producing injury. For the purpose of sounding the œsophagus the English bougies or stomach-tubes are generally employed. They are constructed of a woven tissue impregnated with a gummy material, and can be softened or hardened by dipping them into warm or cold water, respectively. In this way they can be bent into any desired shape. The stomach-tubes are also employed for feeding the patients. Portions of tumors may be caught by the openings situated near their tip.

Before passing a bougie artificial teeth should be removed from the mouth and the patient examined for aneurism of the aorta. In cases of the latter, examination with bougies has frequently caused death from hemorrhage.

Flexible bougies are passed with the patient in a sitting posture, the head being held erect, or even a little bent forward, as in this way the entrance to the pharynx is somewhat widened. For the latter reason the passage of bougies is usually easy in cases with kyphosis of the spine. (v. Hacker.) While with the index finger of the left hand the back of the tongue is gently pressed downward and forward, the bougie, after having been slightly bent, is passed with the right hand over the tongue as far as the posterior pharyngeal wall.

Patients who are being examined for the first time are liable to gag and to stop breathing; they should be urged to breathe deeply and slowly. By holding the head in the above-mentioned position, the thyroid cartilage is not pressed backward, as it is when the head is extended; and if this obstruction is removed, the entrance of the bougie into the larynx can safely be avoided. The last-mentioned occurrence, which need not be apprehended under normal conditions, is observed particularly in cases in which there is constriction of the entrance to the œsophagus, and is favored by a bulging forward of the posterior pharyngeal wall, defects of the epiglottis, and anæsthesia of the larynx. (Chiari.) If the passage of the bougie meets with obstruction, it is sufficient under normal conditions to withdraw the bougie a little, and then again carefully advance it, or direct the patient to swallow, or to bend the head farther forward, or to grasp the larynx with the left hand and draw it away from the vertebral column. The head should not be bent backward except when straight, rigid instruments

(œsophagoscopes, etc.) are passed. This position is useful, however, after the bougie has entered the upper portion of the œsophagus by rendering it possible to advance and palpate in a straight line. If a stomach-tube is to be passed through the nose, the former should be slowly forced downward as soon as it has reached the posterior pharyngeal wall. A finger passed through the mouth or a blunt hook may serve as a guide. (König.)

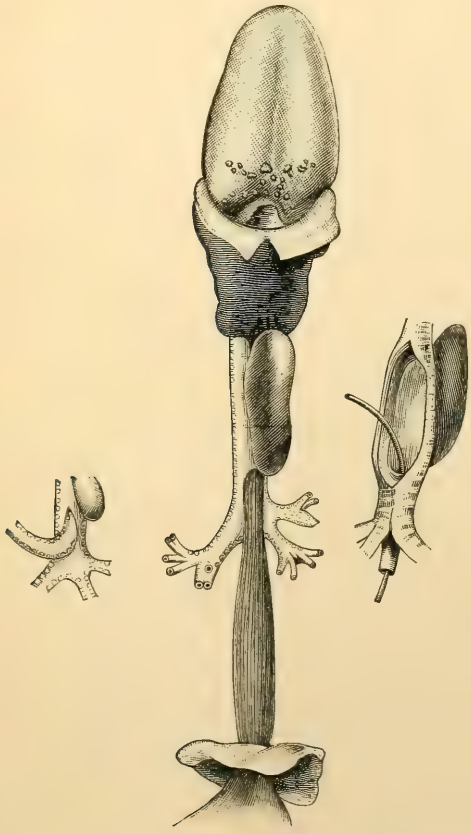
CHAPTER II.

MALFORMATIONS OF THE ŒSOPHAGUS.

By Dr. G. LOTHEISSEN.

Very few of the congenital deformities of the œsophagus possess practical significance. They will therefore be only briefly mentioned. There are usually other deformities presented at the same time, as a

Fig. 3.



Congenital division of the œsophagus and œsophageal tracheal fistula.

result of which children are born dead (35 per cent.) or die within the first week (about 88 per cent. of those born alive). Furthermore, such

children have so little vitality that only in rare cases would they survive any possible therapeutic measures.

The most common deformity is division of the œsophagus into two portions, usually blind pouches, with or without communication with the trachea. (Fig. 3.) The upper portion may be normally developed or like a diverticulum, forming a saccular dilatation terminating a little above the bifurcation of the trachea. In rare cases there is a small fistula communicating with the trachea. The lower portion, proceeding upward from the stomach, is frequently very short and narrow, and either terminates blindly above or passes directly into the tracheal tube. The posterior wall of the latter may be absent to a greater or less extent. The lower portion does not communicate with the upper portion, or may be connected with the latter by a fibrous cord. Occasionally there are found on the posterior wall of the trachea a few muscular bands which connect the upper and lower portions. At times the lower portion is represented only by a fibrous cord. In such cases there is naturally no communication with the trachea.

The origin of this deformity is explained by the development of the œsophagus and the trachea. The trachea and lungs are developed from the ventral portion of the foregut. For some time there is a cleft between the trachea and œosophagus before separation becomes complete (about the end of the first fœtal month). Disturbance of development during this period may produce the various forms of deformity.

In such cases children cannot swallow at all or the food flows out through the nose. During inspiration a gurgling sound can be heard (Lefour), which is due to the communication between the lower portion and the trachea. In several cases closure of the œsophagus was determined by examination with a bougie. Children continue to live only a short time (thirteen days at the longest); they die of inanition, as no nourishment can enter the stomach, or of pneumonia caused by food from the upper portion or gastric mucus from the lower portion entering the lungs.

Provided no other deformity exists, gastrostomy may accomplish some good. If the child survives the operation and gains strength, it might be possible by passing bougies from the stomach to determine how high the lower portion of the œsophagus extended. It might also be possible to pass metal catheters into the upper and lower portions and take an *x*-ray picture. If the distance between the two parts was not very great—if, for example, there was only a diaphragm between the two parts—an attempt might be made to divide the latter by a kind of internal œsophagotomy, followed by dilatation of the stricture. According to v. Hacker's suggestion, the septum between the two blind sacs might be crushed through with appropriate instruments similar to the method employed by v. Bergmann in a case of stricture near the cardia. In this connection a kind of Murphy button has been considered, the halves of which are to be passed from above and through the gastric fistula, respectively. If the diaphragm is situated

rather high, external œsophagotomy might facilitate the operation. Such interference would be especially indicated in cases in which no communication with the trachea could be discovered. But even where there is a communication with the trachea the contents of the œsophagus do not necessarily enter the trachea, as the walls of the fistula usually lie close together. (Lamb.) Sédillot believes that fistulæ can heal spontaneously. This is improbable. If there were only a communication between the trachea and the œsophagus, it might be possible to feed children with a stomach-tube till they were sufficiently strong to undergo gastrostomy.

Fig. 4.

Congenital malformation of the œsophagus. Upper portion ends in a culde-sac; the lower portion opens into the trachea (Harvard Med. School, Warren Museum).

Disregarding complete absence of the œsophagus, the form of deformity described represents a type from which the other forms can readily be derived. It is perfectly conceivable that the œsophagus might be divided into two portions, separated only by a transverse membrane (not positively observed, Ténon's case), or that at this site there remained a constriction. Brenner's case probably belongs to this group. In a twenty-one year old woman he found an annular fold, and below the latter an œsophagotracheal fistula. After performing external œsophagotomy he split the fold longitudinally and sutured it transversely. The fistula was sutured after dissecting away the mucous membrane.

Congenital strictures have been confirmed only twice on post-mortem examination in children. (Turner, Hirschsprung.) More frequently there have been found strictures in the bodies of individuals who had suffered from difficulty of swallowing since earliest childhood. They were annular or tubular in shape and situated in the upper portion of the œsophagus. (E. Horne, Cassau, Zenker, Schneider.) They occurred in elderly people in whom the disturbances had not undergone any change in the course of years; no trace of cicatricial formation could be discovered. Very similar strictures have been observed in the *lowest* portion of the œsophagus. To this category belong the cases of Turner, Crary, Mayer, and Hirschsprung. The symptoms, diagnosis, and treatment of these cases are the same as in those of acquired stricture. There is more prospect of obtaining permanent results by the treatment, as actual scar-tissue is absent and there is thus no tendency to recur.

Those cases may be mentioned also in which the œsophagus is normally developed, but in which there is an œsophagotracheal fistula.

CHAPTER III.

INJURIES OF THE ŒSOPHAGUS.

By Prof. Dr. V. v. HACKER.

TRAUMA FROM AN INTERNAL SOURCE.

Among injuries of the œsophagus produced by violence from within are: injuries resulting from foreign bodies that have been swallowed or have entered the œsophagus in some other way; also injuries caused by bougies, coin-catchers, and other instruments. The latter form of injury is particularly liable to occur if there are pathological changes of the œsophagus, such as carcinoma, ulcer, stricture, etc. The instrument may penetrate or perforate the wall of the œsophagus, or even enter the pleural cavity or mediastinum, setting up fatal mediastinitis or pleuritis. These injuries will be discussed when treating of foreign bodies, phlegmonous œsophagitis, perforation and stricture of the œsophagus.

Burns of the œsophagus and injuries produced by caustics will be considered when discussing corrosive œsophagitis.

EXTERNAL INJURIES OF THE ŒSOPHAGUS.

Owing to the deep situation of this organ, injuries of the œsophagus through violence from without (stab-, incised, and gunshot-wounds) are extremely rare. This discussion belongs more properly to the chapters on injuries of the neck and thorax for the reason that their prognosis depends upon the coexisting injury of the neighboring organs, and for this reason only the more important features will be mentioned here.

In the neck the most important injuries are those of the large vessels and nerve-trunks and the respiratory passages, and in the thorax those of the pleura, the lungs, heart, etc. In injuries of the neck it is hardly practicable to carry out a distinction between the pharynx and the œsophagus.

According to Wolzendorf, the mortality of gunshot-wounds is twice that of incised wounds (44.2 : 22.5 per cent.); gunshot-wounds are more frequently followed by strictures (7.7 : 3.8 per cent.), but fistula occurs less frequently than in incised wounds (3.8 : 18.8 per cent.). The mortality of stab-wounds of the cervical portion of the œsophagus is the same as that of gunshot-wounds.

Wounds and Injuries of the Cervical Portion of the Œsophagus.—In the anterior portion of the neck stab- and gunshot-wounds are generally more dangerous than the incised wounds commonly pro-

duced in attempts at suicide, owing to the fact that vessels and nerves are more frequently injured in the former, particularly in gunshot-wounds; death frequently takes place rapidly as a result of the latter or through injuries of the spinal cord; on the other hand, there are cases in which a bullet has passed between the trachea and the œsophagus, subsequently causing erosion of the œsophagus; there are cases, moreover, in which a projectile travelled transversely through the neck and, glancing from the vertebræ, was swallowed, its escape through the bowels being the first sign of a perforation of the œsophagus. A few cases of isolated gunshot injuries of the trachea and œsophagus are mentioned in literature; the majority of them recovered. In stab-wounds either both passages or only one of them is injured.

In Wolzendorf's 7 cases (with 3 deaths) the stab-wound was either directly from before backward or from one side to the other. In the first group the trachea and œsophagus were more frequently injured, but this may occur also in cases of the second group. The symptoms, course, and treatment will then be the same as those of incised wounds. Even in an unskilfully performed tracheotomy, if the posterior wall be divided, as is particularly liable in the small trachea of a child, a stab- or incised wound of the œsophagus is liable to ensue. Such cases have been described in literature. The author himself witnessed the post-mortem examination of such a case.

In injuries of the cervical portion of the œsophagus there is less danger of mediastinitis than in injuries of the thorax. The former is particularly liable to occur in injuries of the neck where the posterior wall of the œsophagus is traversed by stab-wounds. The reason for this is, that in the neck the escape of œsophageal contents takes place more rapidly, and because, in the second place, where they cannot escape freely enough and inflammatory and phlegmonous manifestations occur in the surrounding tissues, as is usually the case, it is possible by sufficiently enlarging the wound of the œsophagus, or in appropriate cases to suture the latter, and to pack the external wound with iodoform gauze and properly drain it. In other words, it is possible to produce the same conditions as are present after external œsophagotomy. Naturally, if retro-œsophageal abscess or mediastinitis should occur after such injuries of the œsophagus, they should be treated in the same way as in case of perforation by foreign bodies.

Rasumowsky recently reported a case of recovery from gunshot-wound of the œsophagus in the neck in which an ichorous abscess, situated in the posterior mediastinum in front of the vertebral column, was evacuated by means of an œsophagotomy incision.

Of the injuries occurring in civil life, transverse incisions of the neck are especially interesting on account of the fact that frequently the alimentary and respiratory passages are injured at the same time. They usually occur as a result of attempted suicide, rarely as a result of attempted homicide. In the majority of these cases the penetrating instrument had entered between the larynx and the hyoid bone, or through the larynx itself, less frequently through the trachea, and very

rarely above the hyoid bone. (Hoffmann.) In most cases therefore the surgeon has to deal with injuries of the pharynx rather than with those of the œsophagus itself. At this level the large vascular and nerve-trunks are situated at the side of the larynx, and are well protected by the sternomastoid muscle, the latter being usually in a state of contraction. Incisions between the hyoid bone and the thyroid cartilage involve these important structures less frequently therefore than incisions lower down. For this reason isolated injuries of the respiratory and alimentary passages are more frequent in the former cases.

The most important immediate and ultimate results of the injuries will be discussed among incised wounds of the respiratory passages. As far as the symptoms are concerned, it should be noted that as a rule the pharynx is penetrated, and that consequently, as is true of all wounds of the alimentary passages in the neck, there may be pain on swallowing and escape of food through the wound; that on attempting to swallow, food and fluids may enter the respiratory passages and cause violent attacks of coughing and choking. To the left of the trachea the œsophagus is sometimes only partially cut; under such circumstances the mucous membrane is visible; or if only the muscular coat has been injured, the former bulges outward. If the trachea has been divided transversely, it is displaced downward; the greatest amount of gaping being produced if at the same time the œsophagus is completely divided, in which case the inferior margins of both canals may disappear behind the inferior margin of the wound.

It has been observed a number of times that where the head was strongly bent forward toward the chest, in case of small wounds of the œsophagus, hardly any food escaped on swallowing. If several days have elapsed since injury, there is frequently found a swelling of the neck, which greatly interferes with respiration, and a foul discharge; frequently also the patients complain of unquenchable thirst.

Prognosis.—The prognosis of these injuries is by no means so serious as was formerly believed.

Treatment.—The treatment requires, in the first place, that the danger of asphyxia and hemorrhage be removed. Occasionally the symptoms are so alarming that tracheotomy must rapidly be performed at a lower level. If there is danger of secondary hemorrhage, a tampon-canula should be inserted.

At present attempts are usually made to suture the wounds carefully under antiseptic precautions, provided the condition of the patient renders this possible. In regard to wounds of the œsophagus as they occur in injury of the neck lower down, suturing is to be recommended in all cases in which the tissues are not too much contused and wherever primary union may be expected. The best method of suturing is that employed in suturing the intestines, first the mucous membrane, and then over this the muscular coat. Where the œsophagus has been completely divided and the ends have separated, the latter may be

carefully separated from the surrounding tissues; occasionally this will be the only way of bringing the edges together. In extensive division of the œsophagus union is all the more important, as in these cases a fistula is liable to result.

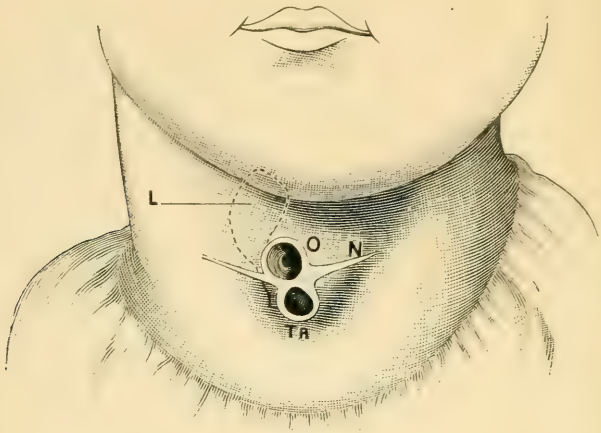
In certain cases in which both canals have been completely divided they should be sutured. In these cases prophylactic tracheotomy as well as iodoform gauze drainage is of the greatest importance. The latter should be placed at the deepest part of the wound, and led out through the external wound, the remaining portions of which should be sutured. Even if primary union of the entire wound of the œsophagus does not occur, the suture will considerably shorten the time of recovery. Formerly, attempts at closing the tracheal wound were not made till after the wound of the œsophagus had healed, and in order to prevent the upper and lower ends of the trachea from being displaced, a T-canula was inserted. During the first days the patient should be fed by the rectum, later by carefully passing a soft stomach-tube through the mouth.

Fistula after Injury of the Respiratory and Alimentary Passages.—Functional recovery from such injuries may be rendered incomplete by the occurrence of a stricture or a fistula. Stricture of the œsophagus, however, has never been observed, not even in those cases in which the latter was completely cut across. Surgeons are indebted to Schüller for a careful investigation of those injuries, and he explains this phenomenon by the fact that repair takes place as a result of the formation of granulation-tissue, which is covered with mucous membrane from the margins of the wound, and not by the formation of a scar. At times, but not very often, a fistula of the œsophagus occurs after injury of both canals. The fistula varies according to the situation of the injury. After incision between the hyoid bone and the thyroid cartilage a fistula occurs, through which the air-passages and alimentary passages communicate with the outside; this is properly a laryngopharyngeal fistula. Where both canals are divided by an incision lower down, a true tracheo-œsophageal fistula is produced; in the latter there are two fistulous openings (as in Figs. 5 and 6). In cases in which a fistula is of greater size, and a great deal of food and saliva escape, nutrition may be impaired. The skin surrounding the fistula may suffer from eczema. Many patients suffering with tracheo-œsophageal fistula are obliged to wear permanently a tracheal canula, as on account of the constriction or obstruction of the superior portions of the larynx they are unable to breathe if the fistula becomes closed, and because if the canula is not left in place the fistula would become smaller as a result of cicatricial contraction. Frequently also they are obliged to take nourishment through a stomach-tube. There is often danger also of particles of food entering the air-passages and setting up bronchitis and pneumonia.

Wounds and Injuries of the Thoracic Portion of the Œsophagus.—In the thorax the œsophagus alone is rarely injured. This may result from injuries with daggers, bayonets, or bullets. Collateral

injuries (heart, lungs, pleura, etc.), which are frequently fatal in themselves on account of their anatomical position, are rarely absent.

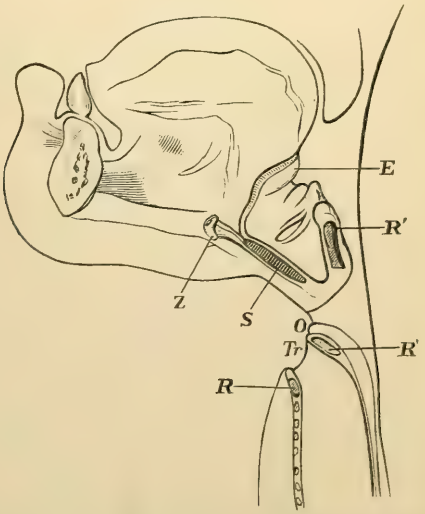
FIG. 5.



Tr, fistula of trachea: *O*, fistula of œsophagus, the latter opening above the transverse scar (*N*) of the incision, which completely divided the trachea and the anterior wall of the œsophagus; *L*, skin-flap subsequently transplanted over the opening of the fistula *O*. (After Schuller.)

The danger of injury of the œsophagus is in itself very great, as on account of the escape of food and saliva into the surrounding tissues

FIG. 6.



O, fistula of œsophagus: *Tr*, fistula of trachea; *R*, *R'*, *R''*, rings of trachea; *S*, thyroid cartilage; *E*, epiglottis; *Z*, hyoid bone.

or into the pleural cavity, where the latter has been opened, progressive ichorous abscesses, mediastinitis, and pleuritis develop. But even

complicated cases may recover. Thus in Wolzendorf's 6 cases of stab-wound of the œsophagus in the thorax complicated by injury of the lung recovery took place in 2.

Symptoms.—One of the most important symptoms is the escape of food through the wound. This symptom may, however, be absent in the beginning or remain absent entirely. The latter is the case particularly in narrow, slit-like stab-wounds. In injury of the lungs there may be attacks of coughing, with bloody expectoration, great anxiety, labored respiration, rapid pulse; eventually air or blood-stained froth issues from the wound or emphysema of the surrounding tissues develops. The patient can lie only on the wounded side; the latter is the seat of violent pain, which becomes tearing in character if substances that are swallowed come in contact with the site of injury. Associated with the above symptoms are great weakness and dyspnœa, followed as a rule by signs of pleuritis and pericarditis, as well as fever. Burning thirst and sighing are considered characteristic also.

Treatment.—The treatment of these injuries is hopeless. So far it has been limited to feeding the patient by the rectum or by means of a stomach-tube passed downward from above the site of injury. The remaining treatment is symptomatic, and only in the event of complications setting in is an operation performed, such as paracentesis of the thorax or thoracotomy if exudation into the pleura has occurred. For the purpose of feeding the patient, providing the condition of the latter permits, gastrostomy is the best method. By means of œsophagoscopy carefully performed it might be possible in a case of partial lateral injury of the œsophagus, to apply an iodoform gauze tampon attached to a string, and allow it to remain in place for a time. Where there are evidences of mediastinal abscess, cervical or dorsal, incision of the mediastinum must be considered. Whenever there is exudation into the pleural cavity, extensive incision of the pleura should be performed.

RUPTURE AND PERFORATION OF THE ŒSOPHAGUS

Rupture.—Rupture of the œsophagus has been observed to occur spontaneously or without apparent cause in rare cases. The majority of these were males and alcoholics. The accident occurred suddenly, as a rule after a hearty meal, usually after vomiting or violent concussion of the body (jumping from a wagon, Mosley). The laceration, involving all coats, is always found close above the cardia, and generally extends into the posterior mediastinum and at the same time into one or both pleural cavities, allowing the contents of the stomach to enter the latter. Laceration is usually longitudinal. Only in the first case described by Boerhave was it circular.

Weeny recently collected 17 authentic cases of rupture of the apparently healthy œsophagus. As Zenker and Ziemssen have pointed out, this is probably due to œsophagomalacia of the lower portion of the œsophagus, caused by autodigestion occurring during life as a result of some peculiar circumstances, so that the exciting force,

whether or not this be contraction of the œsophagus itself, produces torsion of the latter, this organ having, however, previously suffered some alteration which has diminished its power of resistance. At the same time the idea is not impossible that as a result of severe mechanical violence (crushing between car-buffers, striking against the back and the pit of the stomach, Raimondi's case) rupture of a perfectly normal œsophagus may be produced in the same way that rupture of the intestines is produced by such causes.

The accident was as a rule preceded by retching or vomiting, following which the patient suddenly perceived extremely violent pain and a sensation of something having been torn. This was immediately followed as a rule by severe collapse, without further vomiting, and, what was a particularly important sign, by emphysema of the subcutaneous tissues, proceeding from the subclavicular region and rapidly extending over the entire body. This is caused by the entrance of air and gas into the mediastinum. As a rule death occurred within twenty-four hours, preceded by marked dyspnœa and increasing anxiety, the patient continuing in a state of collapse with suppression of urine.

Treatment.—The only treatment besides narcotics would be immediate opening of the posterior mediastinum. In most cases, however, any attempts at operation will be impossible owing to the state of collapse, and because on account of the possibility of perforation of other organs the diagnosis will be uncertain.

Perforations.—Besides resulting from internal and external violence, perforations of the œsophagus may occur in many diseases of the œsophagus itself or of the neighboring organs. The principal diseases of the wall of the œsophagus are various ulcerative processes, particularly those occurring after injuries from within, after injuries from caustics, in case of stricture, and particularly in carcinoma. But other processes (as peptic ulcer) must be borne in mind. According to its location, perforation may take place into the surrounding cellular tissue, mediastinum, or into the trachea, the bronchi, or the lungs themselves, into the pleura, the pericardium, or the neighboring great vessels.

In case of carcinoma situated in the region of the bifurcation of the trachea, perforation into the bronchus, with subsequent fetid bronchitis, pneumonia, and gangrene of the lungs, frequently occurs. Pathological processes of the neighboring organs may cause perforation of the œsophagus from without. In this connection may be mentioned various neoplasms, particularly carcinoma of the thyroid gland, of the trachea, the bronchi and lungs, also descending abscesses of the vertebræ, peri-œsophageal abscess, suppuration or softening of lymph-glands, particularly the bronchial glands, suppuration of the thyroid, gangrene of the lungs, empyema, rupture of aneurisms of the aorta, etc.

In rare cases such perforations occur suddenly; the symptoms under such circumstances will be similar to those of rupture. As a rule per-

foration and communication with the neighboring organs take place slowly, and the characteristic manifestations appear gradually because the pathological processes causing the perforation have previously led to inflammatory, indurated, or carcinomatous infiltration of the surrounding connective tissue. For this reason progressive subcutaneous emphysema, which is such an important sign of rupture, is absent; in fact, under favorable circumstances perforations become closed by cicatrization. More frequently, however, ulceration slowly advances, and may lead to the formation of cavities traversing the mediastinum in various directions, and which may occupy the entire extent of the latter. From these cavities suppuration may affect the important neighboring thoracic organs, with or without perforation of the latter.

Treatment.—The principal object of treatment is to prevent the escape of food through the opening in the œsophagus by the manner of feeding (stomach-tube, by the rectum, through gastric fistula), and to institute operative interference in case of mediastinal abscess, pyopneumothorax, and pyopneumopericardium. The author will refer here to the treatment of peri-œsophageal and mediastinal abscess, and to the case of perforation of the thoracic portion of the œsophagus by a bougie which recovered after he performed incision of the mediastinum.

ŒSOPHAGEAL HEMORRHAGE.

Hemorrhage from the large vascular trunks, such as the subclavian, pulmonary artery, superior vena cava, and particularly the descending aorta, is almost always rapidly fatal whether caused by proliferation and ulceration of carcinoma of the œsophagus or some other ulcerative process, through foreign bodies, pressure of a stomach-tube (Kermanner), or whether conversely an aneurism or similar process ruptures into the œsophagus. If, as a result of the above causes, hemorrhage from smaller vessels occurs, the danger is correspondingly less serious. Perforations caused by foreign bodies are the most frequent. Besides the above-mentioned vessels, the carotid, the thyroid arteries, the inferior thyroid veins, and the vena azygos must be mentioned as sources of hemorrhage. Finally, severe and even fatal hemorrhage is caused by varices. The latter are observed particularly in the lowest portion of the œsophagus, in disturbances of the portal circulation, particularly in the various diseases of the liver (cirrhosis, etc.). Hemorrhage results either from rupture of a varix, injury of the latter by a foreign body, or erosion of the varix in the course of ulceration of the overlying mucous membrane.

Treatment.—Treatment is available only in those cases in which it is possible to locate the injured vessel and ligate it. (See Foreign Bodies.) Hemorrhage from varices usually ceases of itself. In severe cases of hemorrhage from this source treatment would as a rule be instituted too late even if it were possible to diagnosticate the site of the lesion in the œsophagus as opposed to gastric hemorrhage. It is doubtful whether, even in case of a positive diagnosis, the insertion and

inflation of a tampon on a bougie in the manner of a colpeurynter could be carried out. Schneider has considered the possibility of passing his dilating sound for this purpose.

FOREIGN BODIES IN THE ŒSOPHAGUS.

Etiology.—As a rule foreign bodies enter the alimentary passages through the mouth, as in the case of needles held between the teeth. Occasionally portions of food hastily swallowed remain impacted (unchewed pieces of meat, pieces of potato, etc.). More frequently foreign bodies are contained in the food, and thus swallowed, such as pieces of bone, fish-bones, fruit-stones, pieces of glass and enamel. Children in playing are in the habit of placing a great variety of articles into their mouths (stones, coins, keys, glass beads, bones, chestnuts, etc.), occasionally swallowing them. In adults (62 per cent. of the cases, according to Egloff) surgeons have to deal largely with poorly fitted artificial teeth that have not been removed at night, or with bones. Artificial teeth may also be swallowed during attacks of syncope or convulsions (epilepsy) or during anæsthesia if the mouth was not previously examined. Occasionally a foreign body which from its size and character ought to have readily gone down, becomes lodged as a result of some pathological change of the œsophagus (stricture, constriction through compression from without, spastic or paralytic conditions, knuckling, etc.).

The surgeon sees under pathological conditions foreign bodies most frequently impacted in cases of carcinomatous and cicatricial stricture; under such circumstances there is sudden inability to swallow fluids. As these patients generally eat carefully, the surgeon rarely has to deal with large hard foreign bodies in such cases, but more frequently with bits of unchewed meat or smaller hard bodies, such as fruit-stones (plums, cherries); in children, buttons, peas, marbles, etc.

From what has been said, it can readily be understood what a great variety of foreign bodies may enter into consideration. According to Adelmann's classification, they may be divided into bodies with rough, pointed, lacerating surface, which produce injury, and into bodies with a smooth surface, soft and hard, which principally produce obstruction.

In regard to the situations at which foreign bodies may become lodged, it is undoubtedly true that, particularly in the case of small pointed bodies which easily penetrate the mucous membrane, this may occur at any point in the course of the œsophagus. Very large bodies cannot as a rule pass the isthmus, and therefore remain fast in the pharynx. Small sharp-pointed bodies, such as fish-bones, bones, and wooden splinters, which project from the morsel of food, may be driven into the wall of the pharynx during the first attempt at swallowing. Larger bodies which have passed through the pharynx most frequently lodge at those places where under normal conditions the œsophagus is constricted or where it is pressed upon by neighboring organs, or at

places where the œsophagus changes its course. The three constrictions of the œsophagus which are the favorite site for stricture caused by caustics as well as carcinoma (v. Hacker) are: 1, the beginning of the œsophagus, behind the thyroid cartilage; 2, the middle constriction, which in some cases is situated at or above the bifurcation of the trachea, in others more in the region of transition from cervical into thoracic portion; and 3, the inferior constriction situated in the region of the hiatus œsophageus (where the œsophagus passes through the diaphragm). In regard to the middle constriction, it has been confirmed that stricture caused by caustics and carcinoma occurs most frequently in the region of the bifurcation, while foreign bodies that have passed the pharynx and the entrance to the œsophagus, and in which no attempts have been made to force them down, most frequently lodge in the region of the superior aperture of the thorax. (v. Hacker.)

In those cases in which the author found foreign bodies lodged in lower portions of the healthy œsophagus (region of the bifurcation, point of intersection with the left bronchus, or region of the inferior constriction) the former had only reached this situation as a result of attempts at forcing them into the stomach with bougies. The spontaneous descent of larger foreign bodies to the deeper portions is probably rare. The lowest point noted is the hiatus, and not the cardia, as is so frequently stated. If a foreign body has once passed the hiatus, it will lodge in the abdominal portion of the œsophagus only under very exceptional circumstances, as this portion is shaped like a funnel, with its smaller opening placed above. The majority of foreign bodies remain lodged in the cervical portion of the œsophagus. Krönlein (Egloff) explains this by the fact that the œsophagus is wedged in between the vertebral column, the larynx, and the thyroid gland, particularly behind the thyroid cartilage, and in the aperture of the thorax. The latter situation might easily be the seat of obstruction, as here the œsophagus, which is surrounded in the neck by soft, non-resisting structures, passes through an unyielding bony ring into the thorax.

Symptoms and Complications.—The symptoms vary according to the situation of the body and according to whether on account of its size and the character of its surface it produces obstruction of the lumen and pressure upon the surrounding structures (larynx, trachea), or causes injury of the mucous membrane or perforation into adjacent organs (arteries). Some foreign bodies act in both ways. If the body is so large that it cannot advance, and if it remains lodged in the pharynx or in the isthmus behind the larynx, it may by pressing on the entrance to the larynx cause attacks of choking, accompanied by cyanosis of the face, attempts at swallowing, and retching.

If a foreign body completely obstructs the œsophagus, food will be regurgitated. This takes place at once if the obstruction is situated high up, but after a little time when it is situated low down. In those cases in which the foreign body acts as an obstruction the patient complains of a dull sense of pressure, referred to a definite point in cases

in which the cause of obstruction is situated high up; while in cases of foreign bodies with sharp edges which cause injury, the patients complain of a stabbing pain occurring at a certain point whenever swallowing is attempted. Even pointed bodies situated transversely in the œsophagus, with their apices embedded in the latter, may cause more or less complete obstruction, particularly in respect to solid food. In most cases, however, patients can swallow fluids or soft particles of food, though such attempts may cause pain. Pain is referred by the patients to the region of the sternum, even if impaction occurs at a lower site. The pain may frequently continue for days, even if the foreign body has passed beyond the point of impaction.

In individual cases even very large foreign bodies have remained unnoticed in the œsophagus for years, till the development of symptoms caused their removal (Lennox Browne, Le Roy, and McLean removed artificial teeth after three and one-half, seven, and twelve years, respectively). But, on the other hand, foreign bodies which are not immediately dangerous from their size, frequently cause inflammation of the œsophagus through injury of the latter.

The complications occurring after penetration of foreign bodies are quite incalculable. Certainly in many cases met with in daily life the immediate danger is removed by forcing the foreign body either up or down. This may require surgical intervention or be accomplished simply by retching or vomiting or by swallowing solid food. In many such cases, however, dangerous conditions may be produced by injuries of the œsophagus or by subsequent lesions of the gastro-intestinal canal. In many cases the results of foreign bodies penetrating the œsophagus are manifested at once or in a very short time. In injuries of the upper portions blood is frequently mixed with the mucus or vomitus. Severe hemorrhage (vomiting of blood) usually occurs only in the most serious cases in which larger vessels are perforated as a result of impacted pointed foreign bodies. But even in these cases this usually occurs only after some time has elapsed. More extensive fatal hemorrhage is frequently preceded by smaller so-called alarm hemorrhages.

The vessel injured may be the aorta (in 17 of 33 cases of fatal hemorrhage, Poulet), the carotid, thyroid artery, subclavian artery, pulmonary artery, superior vena cava, azygos vein, inferior thyroid vein. The heart itself may occasionally be injured. (Andrew.) (Fig. 7.)

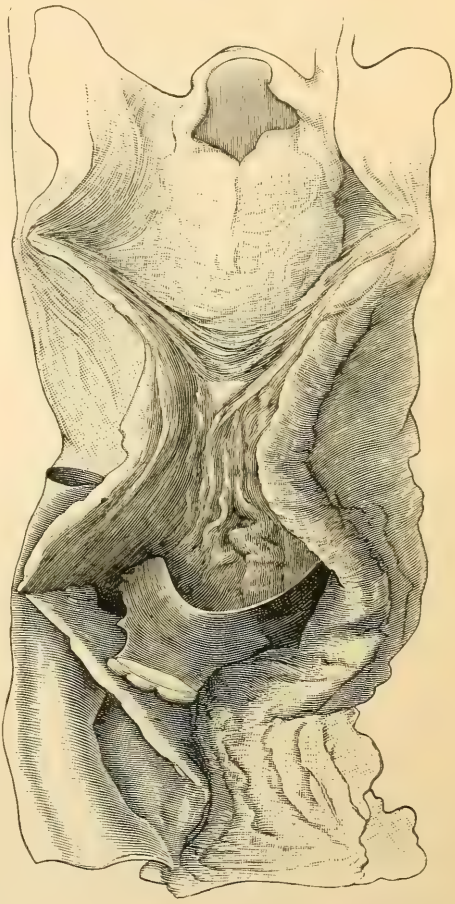
Pointed foreign bodies lodging in the pharynx or œsophagus occasionally lead to local abscess and ulceration, in the course of which the foreign body may become loosened and be either ejected or swallowed. Bodies which perforate the pharynx or the œsophagus may appear in an abscess of the neck or at the side of the vertebral column in the back, in the chest, etc. Needles frequently travel a long distance through the cellular tissue and often appear at the surface of the body or the extremities without leading to diffuse suppuration.

Adelmann's statistics show that even needles are dangerous, for of

40 cases with needle in the œsophagus death was caused in 8, or in 20 per cent.

Foreign bodies lodging high up in the œsophagus may lead to pressure-necrosis of the larynx and trachea, and in this way bring about perichondritis or stenosis of the trachea, followed by cellulitis of the pleura, lungs, and the mediastinum. (Gerster.) In other cases the decomposition of foreign bodies, caused by the entrance of septic materials and the accumulation of decomposing food, may result in ichorous abscesses of the submucous connective tissue. As a result of the latter the mucous membrane may be elevated toward the lumen of the canal and thus produce considerable stenosis, or where there is rupture into the trachea sudden asphyxia or septic pneumonia may develop. As soon as an abscess has advanced to the peri-œsophageal cellular tissue it may rapidly extend along the latter in different directions. More directly this leads to abscess of the neck, corresponding to the seat of the foreign body; eventually there may occur mediastinitis, pleuritis, pericarditis, erosion of larger vessels, and hemorrhage.

FIG. 7.



Perforation of aorta by plate of artificial teeth. Hemorrhage.

In rare cases, as a result of injuries produced by foreign bodies, spasmodic stricture of the œsophagus may occur. If the injury is repeated or deep, and there is inflammation, cicatricial stricture of the œsophagus may result. It is conceivable that to this class belong isolated cases of stricture of the œsophagus resulting from so-called muscular hypertrophy, particularly in the region of the hiatus, where only superficial ulceration of the mucous membrane was present.

Diagnosis.—A positive diagnosis of penetrating or impacted foreign body can occasionally be made from the symptoms and history. On

account of the possible dangers attempts should be made, even in doubtful cases, to determine the presence or confirm the absence of a foreign body.

The pharynx and its environment should be carefully examined by inspection, palpation with the finger, and with the mirror. In most cases, however, the surgeon has to deal with objects which have lodged lower down in the œsophagus. Larger bodies situated in the cervical portion can occasionally be felt from without, along the course of the œsophagus, more frequently on the left side, and sometimes only indistinctly. In other cases there is noticeable tenderness on pressure at a definite point, frequently along the inferior border of the left sterno-cleidomastoid muscle. If secondary inflammatory manifestations have set in, the patient will complain on moving the neck, there may be a noticeable swelling of the neck, or an abscess. If perforation has occurred, there may be crackling due to emphysema.

Foreign bodies may cause rapid swelling of the thyroid gland, in the form of extensive soft struma which had not previously been present. This may result from venous stases caused by the presence of large foreign bodies lodging for several days at the level of the thyroid cartilage and producing difficult respiration (v. Langenbeck), also in case of foreign bodies injuring and penetrating the thyroid gland (Krönlein (Egloff), Gerster), as a result of thyroiditis or strumitis brought about by septic infection. In case of foreign bodies remaining in the œsophagus (König), as well as in the case of foreign bodies that have been removed from the latter, swelling of the thyroid gland may simulate hæmatoma, and thus lead to incision on the wrong side of the neck for the purpose of controlling a supposed hemorrhage from the mouth.

In most cases, besides inspection and palpation, examination with bougies is necessary, particularly in cases of foreign bodies lodged in the thoracic portion, in order to determine the presence and exact situation of the latter. In case of emergency an ordinary English flexible œsophageal bougie can be employed for this purpose; but a block-tin sound is better, especially one with an ivory olivary tip, or, in case of metallic foreign bodies, a whalebone staff provided with a metal spherical tip or any foreign body sound.[1] On touching a foreign body with the latter instrument a rubbing can be heard or at least felt. Care should be taken that the instrument does not rub against the teeth.

In conducting such an examination it is a good plan to have the head of the patient well extended at the outset or as soon as the instrument has passed the isthmus. A straight instrument if passed in a curve, presses backward, and will therefore glide along the posterior wall of the pharynx. It not infrequently happens therefore that foreign bodies attached to the anterior wall cannot be discovered, particu-

[1] This consists of an English flexible bougie provided with a cylindrical tip of ivory or metal. This instrument is not so liable to be caught by the thyroid cartilage on withdrawing it as the bougie a boule is.

larly if their convex surface is applied to the concavity of the anterior wall. This applies particularly to artificial teeth. If this should be the case, the walls of the œsophagus should be palpated by moving the instrument in various directions. If the contact of a foreign body is felt or there is some obstruction preventing advance of the instrument, the distance the instrument has passed from the teeth should be measured. In graduated sounds the distance is simply read off. It is easy to be deceived as to the level of a foreign body even if the latter has been touched. (Wright.) When the foreign body is placed longitudinally, the sound may touch either its upper or its lower extremity; a coin-catcher may touch a foreign body with either the spring or the hook.

After preliminary examination with the bougie, whether positive or negative, the surgeon should at once proceed to perform œsophagoscopy, provided he has mastered the technic of the latter. In case the preliminary examination was positive, it will be known at once what length of tube is to be employed for removing the foreign body. If the preliminary examination was negative, the entire length of the œsophagus should be carefully examined, for in this case the œsophagoscope must serve the purpose of diagnosis as well as treatment. It is important to mention those cases in which it is assumed from the examination with the sound that the foreign body has descended. Many cases are known in literature in which foreign bodies embedded in the œsophagus were not discovered with the bougie, and caused death.

Very small, pointed, embedded foreign bodies are frequently only discovered on slowly withdrawing the tube, as in inserting the latter, just as in using other examining-instruments, they are covered by a fold of mucous membrane. At the site where the body is situated there will be noted at once a marked redness and swelling of the mucous membrane, small hemorrhage, a tear, a waving shred of mucous membrane, a dull-white area of decubitus, or a loss of substance with a purulent coating. The foreign body will be conspicuous by the contrast of its color with that of the mucous membrane. This is particularly the case with pieces of bone. Removal is frequently easy. In difficult cases one may consider the position of the body, the manner of its attachment, or some way of turning it.

Besides examination with bougies and œsophagoscopy there is a third, the most recent method of examination—examination with the *x*-rays, either by means of the *fluoroscope* or *x-ray photograph*. This method has shown itself practicable in numerous instances. Undoubtedly radioscopy is least irksome for the patient, and in case of suitable foreign bodies (bones, artificial teeth, metallic objects, etc.) it is an important aid to diagnosis and may be of importance in controlling the handling of instruments (forceps, coin-catchers).

It is important in case of foreign bodies situated in the lower portion of the œsophagus, where an examination with the fluoroscope or an *x*-ray exposure for a photograph is to be made, to have the patient in an oblique and not in a dorsal position, in order that the object will

not be covered by the shadow of the vertebral column or that of the heart. (Wilms.)

From the point of view of treatment œsophagoscopy is more useful, as by this method the exact relations of the foreign body to the soft parts can be seen, which is not the case in the *x*-ray picture; and it is possible therefore to carry out extraction in the most conservative manner. *X*-ray exposure is particularly important where œsophagoscopy is contraindicated in cases of abscess, and particularly also in perforation of the œsophagus if the foreign body is situated outside the latter, in which case the site of perforation, but not the body itself, can be discovered by the œsophagoscope.

Prognosis.—Owing to the circumstances that many cases are not seen by surgeons, and that of those that are, only a few are kept under observation and completely published, it is impossible to express in figures the prognosis of foreign bodies in the alimentary passages. Large bodies, both soft and hard, in many cases lead rapidly to manifestations of asphyxia or to actual asphyxia. Sharp, angular bodies producing injury frequently bring about serious danger through perforation, ulceration, and their consequences. Every foreign body in the pharynx or œsophagus may cause serious danger or even death. It should therefore be removed as soon and as conservatively as possible

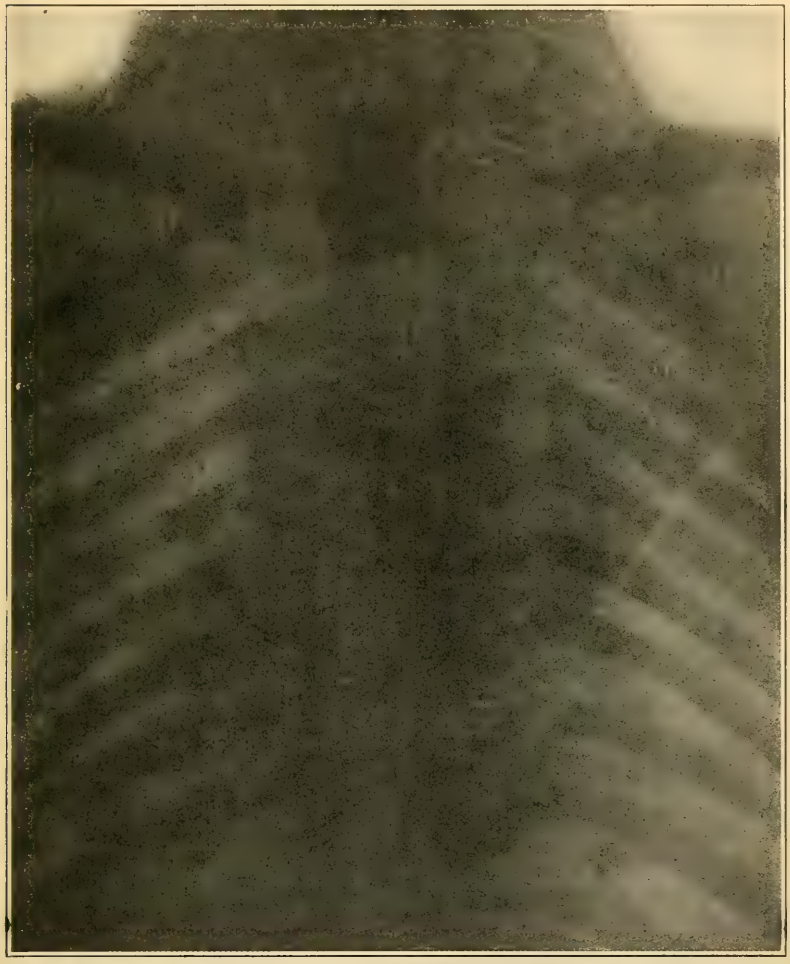
Treatment.—The treatment of foreign bodies should be instituted as soon as the diagnosis has been made. Unfortunately cases usually apply to the surgeon for treatment when complications have already set in as a result of the presence of the foreign body for some time, or as a result of efforts on the part of the patient to remove it (retching, swallowing solid food, use of emetics, etc.), or through attempts on the part of the physician to extract or force it further down.

Where there is danger of asphyxia through impaction of larger bodies (artificial teeth, pieces of meat, etc.) in the lower portions of the pharynx or in the entrance to the œsophagus, it may be possible to remove them with the bent finger, as was successfully accomplished by Dieffenbach and v. Langenbeck among others. If the foreign body cannot be reached with the fingers, a pair of curved pharyngeal forceps should be employed. If there is impending serious danger, tracheotomy must first be performed and attempts at extraction continued subsequently. If the latter are unsuccessful, pharyngotomy or œsophagotomy will be indicated. In case of softer bodies (meat, potato, etc.) attempts may be made to press them against the vertebræ, and by squeezing them render them of such a form as to enable their being swallowed or removed. This removal is carried out by removing successive portions with pharyngeal forceps.

Tracheotomy is necessary in rare cases in which the foreign body has passed the isthmus and is pressing upon the trachea from behind. Usually the efforts on the part of the patient to force out or swallow the body are successful. Dyspnœa can usually be relieved by grasping the larynx and drawing it forward. If in exceptional cases dys-

pnœa is not relieved by tracheotomy, it is due to compression lower down at the bifurcation, as in Ilwraith's case of a child. As there is not sufficient time for œsophagoscopy, attempts should be made to force the foreign body rapidly down with a bougie passed into the œsophagus. It has been recommended to make this attempt in case of dyspnœa even before performing tracheotomy. (W. J. Taylor.)

FIG. 8.



X-ray picture showing plate of artificial teeth in œsophagus at level of upper border of sternum.

In the great majority of cases demanding surgical treatment the surgeon has to deal with foreign bodies that do not produce conditions of acute asphyxia, but are situated lower down in the œsophagus. In these cases must be considered, first, the methods in which no cutting operation is performed, namely, extraction with the aid of œsophagoscopy

or in the absence of the latter; second, extraction through the mouth; or third, forcing the foreign body down into the stomach.

Extraction with the Aid of Œsophagoscopy.—Œsophagoscopy performed after the diagnosis of the site of the body has been made by examination with a bougie, and extraction or pushing the body into the stomach with the aid of the œsophagoscope, constitutes the sovereign method. In a large number of cases in which removal of foreign bodies could not be accomplished with coin-catcher or forceps, this was rapidly and safely effected by means of œsophagoscopy even when the bodies were situated in the lowest portions of the œsophagus. In the same way œsophagoscopy proved itself useful in removing foreign bodies caught by strictures whose extraction by mouth was almost impossible, and where pushing them down was dangerous, as they completely obstruct the lumen, or if sharp can produce an injury that may have serious consequences. It is an equally significant fact that foreign bodies in the normal œsophagus, occasionally also in cases of œsophageal stricture, which obstruct the lumen of the tube, but which are not dangerous on account of their shape and size, frequently glide into the stomach after inserting the tube, evidently as a result of the dilatation of the œsophagus and peristalsis excited thereby. This is especially noticeable in the region of the hiatus.

Occasionally on advancing the tube artificial teeth lodged in the lower portion of the œsophagus glide into the stomach. (v. Hacker, Gottstein.) For artificial teeth without metallic plates that have been caught, Killian has devised a method of inserting a galvanocaustic loop through the tube, cutting up the foreign body with the latter and removing the different portions. Mikulicz is preparing for this purpose a knife-shaped galvanocautery; the author is preparing one that is hook-shaped.

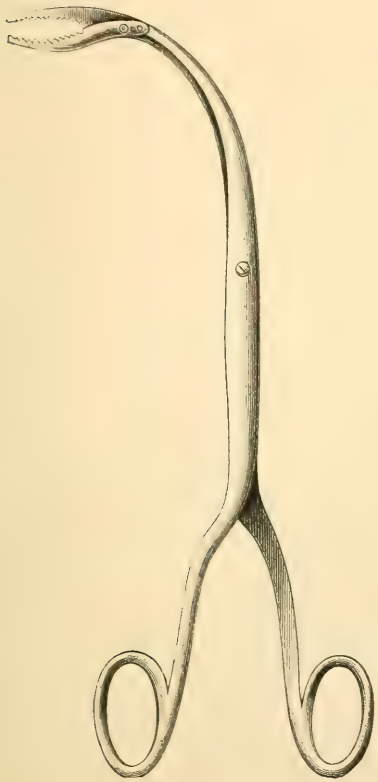
With the aid of the œsophagoscope the author has been able in a series of 27 cases to remove successfully by one method or another foreign bodies lodged in the normal or constricted œsophagus without producing the slightest injury to the patient (except in a case of carcinoma), so that since the year 1887 he has not found it necessary to perform œsophagostomy for foreign body.

Obviously, rational treatment would be limited if removal of a foreign body was to be obtained at any price. In cases in which extraction by conservative methods is impossible because foreign bodies are so firmly embedded, as well as in cases of evident inflammatory or phlegmonous manifestations in the neck, or in the presence of hemorrhage, external operation is indicated. But there are a number of cases in which, by means of œsophagoscopy, œsophagotomy or even gastrotomy can be avoided. For this reason, and in order that the surgeon may be able to determine the indications for any necessary operative interference, it is desirable that he be acquainted with this method of examination.

Extraction through the Mouth.—Removal through the mouth should be aimed at in cases of foreign bodies which by their

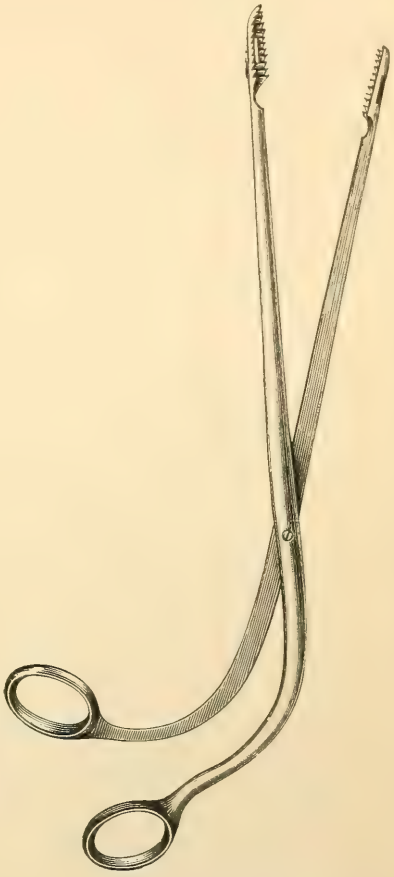
form and character are liable to produce injury, particularly where they are situated in the upper part of the œsophagus, but only if this can be accomplished without using undue force. The longer a foreign body has been embedded, the more must injury and the consequences of the latter (ulceration, abscess) be considered, and the more cautiously must one proceed unless, where the site of the obstruction is

Fig. 9.



Pharyngeal forceps.

Fig. 10.



Œsophageal forceps.

situated in the cervical portion, it is preferable to perform œsophagotomy at once. In case of foreign bodies lodged in the thoracic portion careful attempts at extraction should be made, particularly if on account of the situation of the foreign body the conditions are not favorable for œsophagotomy or for gastrotomy.

For removal through the mouth the following instruments are employed:

1. Various forms of pharyngeal and œsophageal forceps. They

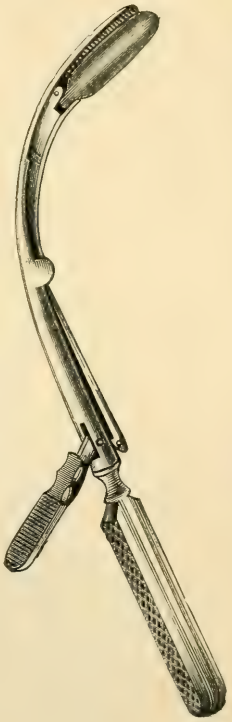
are adapted principally to the removal of foreign bodies from the pharynx and the upper part of the œsophagus.

Two forms of pharyngeal forceps are necessary, such as open from before backward like Charrière's (Fig. 9), and longer œsophageal forceps (Fig. 10); also forceps that open from side to side like the ordinary pharyngeal forceps (Fig. 11), and Lutter's forceps (Fig. 12.)

Fig. 11.

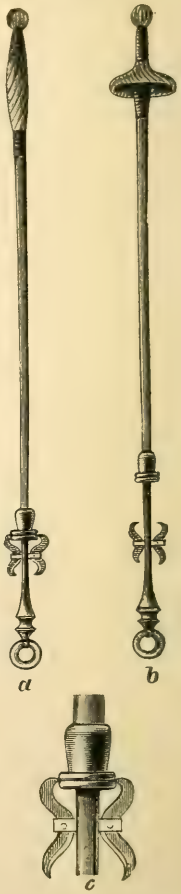
Forceps opening from side to side.

Fig. 12.



Lutter forceps.

Fig. 13.



Weiss fish-bone catcher.

With these instruments it is almost impossible to reach farther than the region of the thyroid cartilage (except with the long œsophageal forceps). They are held in the same way as a bullet-forceps and passed under guidance of the finger.

2. Instruments designed to be passed beyond the foreign body, and which on being withdrawn catch the latter and draw it upward. These instruments are intended principally for objects lodged in the lower part of the œsophagus which do not completely obstruct the latter.

Weiss' fish-bone catcher (brush- or umbrella-probang) is illustrated in Fig. 13, with ring, metal tip, and Sympson's hook contrivance (*c*). It is passed beyond the foreign body with the bristles folded and held in place by Sympson's contrivance (*a*); it is then opened like an umbrella (*b*), and the walls of the œsophagus swept from below upward, the instrument being held with both hands. If by this procedure the probang cannot be withdrawn without using a great deal of force, the bristles are again folded in the same way as when the instrument was passed.

Gräfe's "pharyngeal basket" or coin-catcher consists of a whalebone staff, one end of which carries a small sponge, the other end being provided with a shallow basket which turns on a hinge, or, more useful still, a smooth double hook movable in both directions. (Fig. 14.) A pharyngeal hook with a rigid, hook-shaped metal loop is not so practicable. With a single hook it may easily happen that the hook is directed to the side away from the foreign body. The movable double hook can more readily be passed between the foreign body and the wall of the œsophagus because it can turn from side to side, and because it more readily catches the foreign body on being withdrawn, as experience has shown. If the first attempt is unsuccessful, the instrument should be again passed beyond the foreign body and then turned upon its axis before being withdrawn. If the hook catches the foreign body, the instrument is first drawn tight in order to test it, and thereupon slowly withdrawn without using great force. Before passing the instrument the patient may be allowed to swallow a little oil or egg-albumin in order to facilitate the passage of the instrument. If after catching the foreign body the instrument cannot be withdrawn without exercising undue force, it should be withdrawn alone. Usually this is easily accomplished by passing it down a little and then rotating about its axis. Cases are known, however, in which this failed after repeated efforts, and in which the coin-catcher had to remain a day or longer till œsophagotomy could be performed.

FIG. 14.

Gräfe's coin-catcher.

PUSHING DOWN INTO THE STOMACH.—A foreign body should not be pushed down into the stomach unless it can safely be assumed that this procedure will not be to the disadvantage of the patient. The cases which are adapted to this method are those in which there are softer bodies, tendinous portions of meat, pieces of potato, etc.; also those in which the bodies are not too large, have smooth surfaces and a spherical form, and which cannot easily be grasped with the above extraction-instruments. The best instrument for this purpose is an ordinary œsophageal bougie with cylindrical tip.

In case of soft bodies in a normal œsophagus, and particularly in the presence of stricture, the following method may be useful: A

conical English elastic bougie is slowly passed between the wall of the œsophagus and the foreign body in order to loosen the latter, and then suddenly pulled back with a jerk. The bougie will then pull away a portion of the loosened body and the remainder will then glide into the stomach by itself or with the aid of a cylindrical bougie. The cylindrical bougie should not be suddenly thrust in, but advanced under steadily increasing pressure.

Where these methods are unsuccessful or in those cases in which they are contraindicated from the outset, a surgical operation for the removal of foreign bodies must be employed. Among these are: (1) pharyngotomy; (2) œsophagotomy; (3) gastrotomy and gastrostomy.

FIG. 15.

Coin-catcher. (Brewer.)

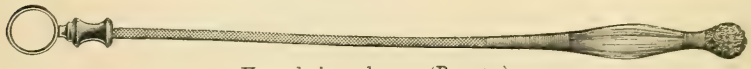
Associated with these as an extreme measure is dorsal œsophagotomy through the mediastinum.

PHARYNGOTOMY.—Pharyngotomy is more fully discussed under injuries and diseases of the nasopharynx. The author may mention here that so far it has only been employed for the removal of foreign bodies from the pharynx (10 cases, Honsell), but never for the removal of foreign bodies from the œsophagus.

ŒSOPHAGOTOMY.—Œsophagotomy is the most important operation in cases of foreign body of the œsophagus and the one most frequently employed. The indications have for the most part been discussed above. G. Fischer has formulated the following general principles, and which assume the presence of a foreign body at a site which renders œsophagotomy practicable:

1. A foreign body recently swallowed, which cannot be removed by other methods, must be removed by œsophagotomy before the end of

FIG. 16.



Horse-hair probang. (Brewer.)

the second day. Impending asphyxiation necessitates immediate tracheotomy.

2. If the foreign body has been swallowed several days previously and one attempt at removal has been unsuccessful, œsophagotomy should immediately be performed.

3. If the nature of the foreign body would render any attempt at extraction or pushing downward unsuccessful, operation should immediately be performed.

4. In cases of existing infiltration of the neck, or if hemorrhage from the mouth has occurred, œsophagotomy should immediately be performed.

It is sufficient to point out here that one of the principal non-bloody methods is œsophagoscopy; that in difficult cases in which, for instance, foreign bodies are lodged in the thoracic portion, the latter method can be employed by means of a short tube inserted through the wound or an artificial fistula. In this way it is possible to obtain a view from a shorter distance than from the mouth, and to ascertain the manner in which the body is caught, how held, and in what way it should be turned, and thus be spared the necessity of performing a gastric operation.

When a foreign body is situated in the thoracic portion and cannot be removed through the mouth by the non-bloody methods nor be pushed down, the question to decide is whether it is better to remove it by means of œsophagotomy or through the stomach. This must be determined by the seat of the foreign body.

Assuming an average length of 25 cm. for the adult male œsophagus, it can generally be said that the beginning of the œsophagus is about as far from the teeth as the cardia is from the bifurcation, or about 15 cm., while the distance from the thyroid cartilage to the bifurcation of the trachea is about 10 cm.

As measurements on the cadaver show that the distance from the sternum to the part of the œsophagus at the level of the bifurcation is about 4–8 cm. in males and 3–6 cm. in females, the average distance from the teeth to the superior aperture of the thorax can be put down as 19–22 cm. in males and 18–21 cm. in females.

Histories of cases published offer little information bearing on this question, as the site of the foreign body is either not stated or else is incorrectly estimated. The majority of foreign bodies removed by means of œsophagotomy were situated behind the larynx, particularly behind the thyroid cartilage and in the region of the superior aperture of the thorax. Occasionally where the foreign body was wedged into the aperture of the thorax difficulty was experienced in grasping it with forceps.

In isolated cases foreign bodies situated 23, 27.5, 28.7, and 33.7 cm. from the teeth were removed (Ström, McLean, Alexander Maunder, etc.). Billroth twice extracted a plum-stone situated several centimetres above the cardia in the case of a woman with a stricture due to swallowing sulphuric acid.

In general, larger foreign bodies wedged fast in the œsophagus cannot be safely removed through the wound with forceps except by the aid of œsophagoscopy unless they can be reached with the finger. These conditions were present in Riedel's case (24 cm. from the teeth, female, twenty-five years old) (Göde). According to Riedel, foreign bodies situated not more than 20 to 26 cm. from the teeth can be removed through an œsophagotomy-wound, provided that it be possible to draw up the œsophagus a little. In case of foreign bodies situated lower down in the thoracic portion œsophagotomy may be attempted, to be followed by gastrotomy if the former is unsuccessful. The œsophagotomy-wound frequently facilitates removal of the foreign body through the stomach.

Technic of Œsophagotomy.—As the œsophagus is situated more to the left, behind the trachea, the operation is as a rule performed on the left side, the patient being placed in a half-sitting posture with the head turned to the right. The operation should be performed on the right side only if there is evidence of an inflammatory phlegmonous process, or if the foreign body has been lodged on the right side for some time and can be felt there, or if it is desirable to divide the wall of the œsophagus on account of inflammatory infiltration or ulceration.

The skin-incision is made along the anterior border of the left sternocleidomastoid from the level of the thyroid cartilage almost to the clavicle. The platysma and superficial fascia are divided along the anterior border of the sternocleidomastoid as far as this muscle, care being taken to avoid injuring the jugular vein. The inner border of the sternomastoid is found and the muscle retracted outward. After dividing the middle fascia of the neck, as well as the omohyoid muscle in case the latter cannot be pulled aside, the dissection is carried on into the deeper tissues, between the left lobe of the thyroid gland, which serves as a guide, and the sternomastoid muscle, both structures being well retracted. The large vessels enclosed in their sheath and the sternocleidomastoid are retracted outward and the sternohyoid and the thyroid gland inward. In the usual cases in which the œsophagus is exposed for a few centimetres below the thyroid cartilage, the superior and inferior thyroid arteries, being situated above and below this space, respectively, can be spared. The superior thyroid artery extends above the beginning of the œsophagus downward and inward across the pharynx. If the œsophagus must be opened lower down, it may be necessary to cut the inferior thyroid artery between ligatures, as after its origin from the subclavian behind the carotid it takes an oblique course, running inward and upward over the œsophagus and crossing the recurrent nerve. If more room is required in exposing the œsophagus as far as the superior aperture of the thorax, the sternal head of the sternomastoid muscle should be divided just as in the case of struma or other tumor. Occasionally, if struma is present, it will be necessary to remove the respective lobe of the thyroid.

The œsophagus will be found at the bottom of the wound, situated to the left of the trachea. It appears as a flattened, rounded band, whose fibres run longitudinally, of a reddish color, and will be recognized possibly by swallowing movements. Behind, can be felt the bodies of the vertebræ covered by the longissimus colli muscle. As the recurrent nerve runs in the groove between the trachea and œsophagus, it is better to open the latter at the side. By inserting an English elastic catheter or a whalebone or tin sound through the mouth, the wall may be pushed outward at this site. Occasionally the latter condition will be produced by the foreign body. Where there is perforation of the œsophagus purulent infiltration and œdema of the surrounding tissues will serve as a guide. The muscular coat

is strong and only loosely attached to the mucous membrane. It is of advantage therefore in incising the œsophagus to hold the wall of the latter firmly with the fingers where it is stretched by the foreign body or over the sound in order that the incision may be carried through the mucosa. The edges of the incision should be immediately retracted by means of two ligatures passed through all the layers. (Billroth.) If the opening be made free hand, it is best accomplished by means of two forceps, grasping first the muscular layer and then the mucosa.

The foreign body is as a rule found lying near the wound or can be felt with the finger. It should be removed with a straight or curved pair of forceps. If this fails, the œsophagus, which should be firmly held by the ligatures, must be opened farther in one direction or the other. If fingers or forceps slip and the foreign body is wedged in, it must be loosened by means of elevators or turned, or occasionally broken up with bone-forceps. (Lawson.)

In case of foreign bodies that are liable to produce injury care must be taken to prevent the edges of the wound from being torn during their removal. Where foreign bodies are situated in the lower thoracic portion removal may be facilitated by gently drawing up and stretching the œsophagus. Under these circumstances œsophagoscopy through the wound should be considered. In a number of cases foreign bodies were not found after operation or they disappeared in the course of the latter, having passed into the stomach unnoticed as a result of relaxation of the œsophagus during anæsthesia or as a result of the incision.

After-treatment.—The wound of the œsophagus should be sutured in those cases only in which the latter was not contused during extraction, in which the foreign body was present for a short time only, and in which no inflammatory manifestations, pressure-necrosis, or ulceration is present. Either catgut or silk is employed for suturing. In order to prevent separation of the sutured edges by muscular contraction the mucosa and the muscular layer can be sutured separately. But even this will not absolutely prevent separation. Even under the most favorable circumstances suturing is not followed by primary union, and generally only prevents or limits the escape of food during the first period. It is advisable therefore to drain the rest of the wound with iodoform gauze, following which the skin-incision, with the exception of its lower angle, can be closed. In all cases in which primary union is not to be expected a drain or stomach-tube should be passed into the œsophagus as far as the stomach and the wound about the tube filled with iodoform gauze in order that pressure of the tube will not cause necrosis. In doubtful cases it is better to adopt the open method of treatment, as experience has shown that the period of recovery is not materially shortened by suturing. If the wound in the œsophagus is not large, it soon contracts, and recovery may be completed in twelve or fourteen days, which is about the same time in which suturing is successful, as the cases in Billroth's clinic, among

others, have shown. Complete primary union without drainage, as obtained elsewhere, is impossible under any condition after œsophagotomy.

As far as the feeding of the patient is concerned, it is necessary in exceptionally weak individuals to pass a drain through the nose into the stomach and allow this to remain in place for the first few days. Fairly well nourished patients can be fed by the rectum for a few days, after which the patients are allowed to swallow nourishment. In some cases this can be done a few hours after operation. Where the open method of treatment is employed, nourishment for the first eight days is provided through the tube inserted into the wound. After this the tube is removed and the patient allowed to swallow. In the beginning the wound in the œsophagus can be held closed by using two fingers.

It is only recently that this operation has been more frequently employed. The relatively high mortality, about 24 per cent. (Fischer's statistics, with the addition of the cases compiled by Egloff, Fedoroff, and Bull-Walker, show 184 cases with 45 deaths), cannot be referred to the operation itself, but to the ulceration, perforation, and gangrene of the œsophagus, erosion of bloodvessels, exhaustion, etc., produced by the foreign bodies. In other words, the high mortality is due to the fact that œsophagotomy was performed too late. The operation itself is not very dangerous; thus all of the 9 cases operated upon in Billroth's and Gussenbauer's clinic from the year 1880 to 1897 recovered.

Gastrotomy and Gastrostomy.—Removal through the stomach is indicated in all cases of foreign bodies situated too low in the thoracic portion to be reached by œsophagotomy, which cannot be removed by the latter operation or by other means. It is adapted therefore to cases in which foreign bodies are situated 26 cm. or more from the teeth, as well as those situated near the cardial end of the œsophagus, particularly in case of large, angular, irregular-shaped bodies.

For the surgeon who is skilled in the use of the œsophagoscope the indications for gastrotomy will be as infrequent as for œsophagotomy, particularly in case of rounded hard bodies which do not produce injury. Artificial teeth, bones, apricot-stones, etc., situated below the bifurcation and at the level of the diaphragm, can usually be extracted without difficulty or danger. Occasionally where the tube is passed far down, dilatation of the œsophagus will result in the body passing into the stomach or in allowing it to be easily pushed down. In case foreign bodies are lodged immediately above the cardia, even where they are liable to produce injury, the latter procedure is justifiable. Even if gastrotomy should be subsequently indicated, the latter operation is much simpler and less dangerous where a foreign body is located in the stomach than where it is firmly impacted in the œsophagus. It might be possible in difficult cases to extract a foreign body situated low down in the œsophagus through the gastrotomy-wound by loosening the foreign body during anæsthesia with forceps by the aid of the

œsophagoscope, so as to place it within reach of the finger passed through the stomach.

In the removal of foreign bodies situated low down in the thoracic portion there is always the disadvantage that this portion of the œsophagus cannot, like the cervical portion, be exposed, and that therefore operation must be carried out in the dark. Gastrotomy and gastrostomy must now be considered.

Gastrotomy is particularly applicable in cases in which foreign bodies are situated near the cardia and the œsophagus is normal. Various methods may be employed:

1. The index finger may be introduced into the stomach through a small opening high in the fundus. (Wilms.) The finger is surrounded by a purse-string suture which holds the stomach-wall in close contact with it, and the anterior wall of the stomach is pushed in sufficiently to allow the finger to pass through the cardia to the foreign body.

2. Method of passing instruments (forceps, etc.) through an opening in the stomach, the latter being held well beyond the edges of the abdominal wound. By this method Trendelenburg was able to remove artificial teeth through a small opening in the stomach with forceps.

3. Method of passing the hand into the stomach after the latter has been opened and retracted with ligatures. (The incision in the stomach should be about 13 cm. long.)

4. Method of passing the hand into the stomach after the latter has been temporarily sutured to the abdominal wall and only subsequently opened. (Trendelenburg, Quadflieg.)

5. Method of employing a string.[1]

Where the foreign body was situated high up, a small sound was passed either from above or through the stomach. To this was attached a piece of string armed with a sponge or piece of drainage-tube, the purpose of the latter being to pull the foreign body upward into the mouth or down into the stomach (Bull, Finney, peach-stone). This procedure and attempts at removal in general are rendered easier by previously performing œsophagotomy, although rarely except in children is it possible to make the fingers touch when passed into the stomach and the wound in the neck, respectively.[2]

Only by the method of Wilms (folding in the anterior wall) or by passing the hand into the stomach is it possible to enter the cardia with the finger, and even then it may be very difficult. If the stomach is drawn forward and retracted and only one finger inserted, it is impossible to reach the cardia, which is situated at about 20 cm. from the anterior abdominal wall. In more difficult cases, particularly those in which foreign bodies are impacted above the cardia, and in which various procedures are necessary in order to loosen and bring down

[1] It is assumed that the methods described under 2, 3, and 4 have previously been performed.

[2] This was repeatedly attempted on the cadaver at Trendelenburg's clinic by Wilms and by the author, and always failed.

the former, passing in the whole hand will be the most practicable method, experience having shown that a smaller incision of the stomach is not adequate in complicated cases. (Richardson, Wallace, and others.)

The entrance of stomach contents into the abdominal cavity should be carefully avoided by retracting and packing around the stomach. The method described under 4 should only be employed when the stomach is well drawn forward and retracted.

The opening of the cardia is frequently obstructed by folds. Entrance into the latter may be facilitated both when using the index finger alone according to Wilms, or when the whole hand is passed into the stomach by pushing the finger along the lesser curvature, by stretching the stomach in this direction, or by lifting up the right wall. (v. Hacker.) Where the incision into the stomach is larger, the walls can be held apart and the cardial opening exposed to view.

The abdominal incisions employed are either Fenger's parallel with the left costal arch, or a longitudinal incision at the outer border of the left rectus muscle; more recently a median incision has been employed. The fold of the stomach is drawn forward and retracted and opened by an incision parallel with the greater curvature, or, better, parallel with and between the bloodvessels. The edges of the stomach are grasped with clamps or held by ligatures and drawn over the edges of the abdominal wound, and then held sufficiently far apart to allow the operator to pass in one hand. After removal has been completed the wound in the stomach should be carefully sutured.

Gastrotomy for the removal of foreign bodies from the lower portion of the œsophagus has produced excellent results in selected cases. In 15 cases (Richardson, Bull, Trendelenburg, Finney, White, Wallace, Morton, Lejars, Stunbo (Romm), Fl. Edmunds, Thiriar, Quadflieg, Wilms, Hansy) extraction was successful; 2 of these died and 13 recovered. Gastrotomy was unsuccessful in 4 cases. (Stelzner, Henle, Enderlen, Jacobson.)

Gastrostomy combined with the string method discussed under gastrotomy, is particularly serviceable in cases in which foreign bodies are situated at a distance, and in which there is tight stricture of the œsophagus, the object being to dilate the latter at the same time. It may also be successful in cases in which the œsophagus is normal, in the presence of soft or rounded bodies that are not liable to produce injury.

Dorsal or Thoracic Œsophagotomy.—Œsophagotomy through the posterior mediastinum is the method of last resort in the case of foreign bodies lodged in the intrathoracic portions of the œsophagus (particularly below the bifurcation) when—and only under such conditions—these bodies cannot be removed by other more conservative method and purulent mediastinitis is apprehended.

The dangers of dorsal mediastinotomy (see page 56) are increased by opening the œsophagus through the wound of the former. Gastrotomy should be previously performed for the purpose of supplying

nourishment to the patient. If the pleura has remained intact, the œsophagus should be opened at once. Where there is extensive injury of the former this should be postponed till there is firm adhesion of the layers of the pleura, the wound having been packed with iodoform gauze for several days.

This operation has been performed twice to remove artificial teeth (Henle, Enderlen; Forgue opened only the mediastinum). Enderlen's patient was the only one to recover, but in consequence of abscess of the liver and subphrenic abscess (preliminary gastrotomy had not been performed) convalescence was protracted; the œsophageal fistula closed only after nine months.

Treatment of Complications of Foreign Body in the Œsophagus.— The most important complications which follow the swallowing of foreign bodies are hemorrhage and phlegmonous processes resulting from injuries of the œsophagus. There may be severe hemorrhage where the foreign body is situated partially or entirely within the œsophagus, or where in case of perforation it is situated outside and adjacent to the latter. Hemorrhage may also take place after removal of the foreign body through the mouth or through the œsophagotomy-wound. Where œsophagotomy has been performed there is hemorrhage from the wound, otherwise it occurs from the mouth. There may or may not be vomiting of swallowed blood.

Hemorrhage from the mouth is caused by injury of the vessels of the neck, less frequently by injury of one of the œsophageal vessels. Its occurrence will necessitate exposure and ligation of the respective vessels. As soon as the seat of the foreign body has been determined œsophagotomy should be performed. In the course of the latter operation the injured vessel should if possible be ligated before the œsophagus is opened. The presence of hemorrhage into the tissues surrounding the œsophagus before the latter has been opened would point to perforation of the latter and render it advisable to search carefully for the injured vessel in the tissues surrounding the wound of the œsophagus in order to tie it, at a time when the parts are not displaced and the contents of the œsophagus have not escaped. Not till then should the œsophagus be opened and the foreign body removed. If there is no perforation of the œsophagus, hemorrhage must arise from one of the vessels in the wall of the œsophagus. This may be the case also where the œsophagus has been perforated by a foreign body, but the accident is rare.

If during the operation there are no signs of perforation in the surrounding tissues, and if upon opening the œsophagus it is seen that the foreign body has penetrated the wall of the œsophagus in another direction, and if this site is surrounded by blood-clots, it is advisable to look for an injured vessel in the wall of this portion, or even to dissect out the tissues surrounding the œsophagus at this site in order to find the injured vessel.

In nearly every instance of hemorrhage in case of foreign body the former is due to erosion of one of the vessels of the neck, whether

it takes place before or after removal of the foreign body or after œsophagotomy. Of the smaller vessels, the inferior thyroid artery or its branches is most frequently injured. For this reason it has been proposed to tie this vessel in those cases in which it is impossible to find the injured vessel in the wound. This is an uncertain procedure, as among the cases published hemorrhage has resulted also from injury of the ascending cervical artery (Rose), common carotid artery (Billroth), internal jugular vein (Gerster, Weinlechner), and the œsophageal veins (Hochenegg).

If hemorrhage is serious and the injured vessel cannot be found, it will be necessary to tie the common carotid artery in its lower third. If it is uncertain whether the ligated vessel is the actual source of hemorrhage, or if during the operation the carotid artery is found lying close to the foreign body or to the focal abscess caused by the latter, and if it is uncertain whether the walls of the vessels are injured or not (Ardle), a provisional ligature may be passed about the carotid without being tied, according to Annandale's suggestion. If secondary hemorrhage does not take place, the ligature can subsequently be removed.

Where there is severe secondary hemorrhage from the wound after œsophagotomy the same procedure may be employed. Whether hemorrhage is caused by injury of a large vessel during operation or, as has more frequently been the case, is caused by pressure-necrosis from an œsophageal tube inserted for the purpose of supplying nourishment, the above method should be employed. It is advisable not to choose too large a tube. The latter should preferably be left in place for a few days only. (See Decubital Ulcers.)

Where hemorrhage occurs after removal of the foreign bodies by œsophagotomy death generally takes place instantly, as in the cases of Bose, Krönlein (inferior thyroid artery), Gerster, and Weinlechner. Ligation of the injured vessel is rarely followed by recovery (inferior thyroid artery, Frew ; inferior thyroid vein, Krönlein). Even where, after severe hemorrhage, the opening in the vessel is temporarily closed by a blood-clot and the vessel can be quickly tied (Billroth, carotid) the patients soon die from loss of blood.

Treatment of Retro-œsophageal Abscess, Empyema, and Pyopneumothorax.—Contrasted with those cases mentioned above, in which the foreign body produces an ulcer or circumscribed abscess, there are other cases in which abscesses of the neck or rapidly advancing inflammation of the submucous and peri-œsophageal tissues as a result of infection of the site of injury by the decomposing body or by the entrance of decomposed food occur. This is particularly liable to happen where perforation is caused by the stomach-tube.

It is of practical importance that these phlegmonous processes following ulceration, perforation, or gangrene of the œsophagus, which may lead to suppuration of the pleura, to pneumonia, and gangrene of the lungs, as a rule first involve the loose connective tissue between the vertebral column and the œsophagus, and then extend from the

latter. Accordingly one can hope to check the progress of the disease by opening this space early. Unfortunately, however, these processes show a septic tendency from the outset, more frequently causing diffuse seropurulent infiltration of tissues than the formation of pus.

The onset of abscess is characterized by fever not necessarily high, occasionally ushered in by chills, accompanied at times by marked swelling of the pharyngeal mucous membrane (at times there is distinct swelling of the posterior pharyngeal wall), also pain on swallowing or moving the neck, frequently also difficulty in breathing, which may develop into asphyxia if œdema of the glottis should occur. These symptoms may rapidly lead to the formation of a fluctuating retropharyngeal abscess. If the abscess extends lower down or is situated lower down from the outset, there will be tenderness of the neck and a doughy swelling at one or both sides of the trachea and larynx, with or without crepitating emphysema. The neck has been found inflamed and swollen, and the cellular tissue at the side of the œsophagus infiltrated with pus as early as two or three days after injury of the œsophagus. In a number of cases in which a bone had been swallowed there was gangrene of the wall of the œsophagus, as well as abscess of the mediastinum and pleuritis, on the fourth day after the accident. Subcutaneous emphysema of the neck is an extremely important and ominous symptom. In case of foreign bodies perforation of the œsophagus will first be thought of. In abscesses which rapidly undergo ichorous decomposition emphysema may be due to the formation of gas.

In all cases of abscess caused by foreign bodies, as well as in many cases of abscess of the neck, an external incision like that employed for œsophagotomy should be made. By means of the latter the site of perforation should be exposed, the foreign body removed, and all purulent or ichorous tissue opened up. If the abscess extends behind the viscus, or even to the opposite side, or if the body has perforated in that direction, a similar incision should be made on the other side also and carried well into the retro-œsophageal tissue, so that this space may be packed with iodoform gauze from both sides; at the same time treatment should be directed toward suppuration proceeding in other directions (trachea, retropharyngeal space, etc.).

The *prognosis* of existing abscess of the neck is usually unfavorable. Even when it is possible by means of operation to prevent its progress, aspiration of septic material may have already caused fetid bronchitis, pneumonia with subsequent abscess or gangrene of the lungs, and ichorous pleuritis. The conditions become still more unfavorable when abscesses extend into the thorax, or if the foreign body has produced an injury and abscess in the latter region. In these cases abscesses develop in various directions (pleura, pericardium, stomach, with secondary affections of the lungs, empyema, pyopneumothorax); also hemorrhage from the thoracic vessels (aorta), etc., besides direct perforation of neighboring organs by foreign bodies.

Very rarely injury or perforation of the œsophagus by a foreign body is followed by empyema or pyopneumothorax. Empyema may

originate in the neighborhood of the perforation if the latter is situated in the thoracic portion, cases being known where, corresponding to the anatomical situation, perforation took place directly into the pleural cavity, the foreign body escaping into the latter, or where the perforation was situated higher and at a distance, in which empyema was caused by secondary rupture of the retro-œsophageal abscess into the pleural cavity. Finally, purulent ichorous pleuritis may occur as in Fischer's case, following perforation of the pharynx, through the medium of a putrid bronchitis, pneumonia, and gangrene, caused by septic infection of the respiratory organs.

Whenever in such cases there is exudation into the pleural cavity, the latter should be immediately opened by extensive incision. The same is true in case of exudation into the pericardium as soon as exploratory puncture shows pus.

In those cases in which abscesses of the neck extend into the superior mediastinum or in which abscesses originate in the latter and ascend to the neck, the easier or less dangerous operation should be performed, namely, opening the abscess in the neck, from which region the third dorsal vertebra can be reached (cervical mediastinotomy). If the operation is unsuccessful, or if the abscess is situated lower down in the mediastinum, it may be necessary to consider opening of the posterior mediastinum through the back (dorsal mediastinotomy).

For cervical mediastinotomy, Heidenhain recommends entering above the sternoclavicular articulation (particularly where transverse incision is employed), and between both heads of the sternocleidomastoid muscle, or better still by dividing the latter from the clavicle and advancing on the right side between the common carotid artery and the jugular vein, and on the left side to the outer side of both structures. In two cases the author was successful by making a longitudinal incision along the inner border of the sternomastoid muscle and advancing on the inner side of the large vessels. The localization of pus or subcutaneous emphysema will generally offer information as to the proper route to pursue. Of 6 cases in which the mediastinal cavity was thoroughly opened and drained through the neck, 4 recovered. (Heidenhain, Rasumowsky, v. Hacker, König, Dobbertin.) In the author's case there was perforation of the thoracic portion of the œsophagus by a bougie. Two cases died. (Ziembicki, v. Hacker.) In 2 cases (Ziembicki, König) perforation of the œsophagus by pieces of bone was positively determined.

Nasiloff was the first to suggest rules for opening the posterior mediastinum through the back (dorsal mediastinotomy). Further studies on the cadaver were conducted by Quénu and Hartmann, by Potarca and Bryant. According to the author's investigations on the cadaver, it is possible to expose the œsophagus on either side above the arch of the arota, but it is better to carry out the operation on the left side, as here the œsophagus lies nearer the incision. The same thing was pointed out by Bryant and Nasiloff. Below the arch of the aorta it is easier to gain access and separate the pleura on the right side.

(Bryant, Nasiloff, Potarca.) Quénu and Hartmann recommend proceeding on the left side in all cases, for the reason that on the right side the pleura extends farther behind the œsophagus in the form of a blind sac. Enderlen recommends proceeding on the left side above the bifurcation, on the right side at the level of the fifth and sixth dorsal vertebræ, either the right or left side below the latter as far as the diaphragm.

Incision is generally made longitudinally, midway between the median line and the border of the scapula, dividing and retracting the muscles, the patient being placed either on his back or the opposite side. Quadrilateral (Bryant) or circular flaps, including skin and muscle, extending outward to the inner border of the scapula with the base over the spinous processes (Rehn), have been recommended. After exposing the ribs one of the middle ones is carefully resected subperiosteally, then the others, as many as are necessary. If there is only abscess formation, sufficient room will usually be provided by the resection of 4–6 cm. of three or four ribs, taken from the region of the articulation between the rib and the transverse process. The author does not consider resection of one or two processes (Heidenhain) necessary or advantageous. The separation of the pleura should commence at the transverse process of the vertebræ. If it is intended to expose the œsophagus, etc., it will be necessary to resect greater portions of the ribs (about 10 cm. from as many ribs as necessary, usually about six). During the operation care must be taken that the pleura is not lacerated by the edges of the rib through violent respiratory movements, as happened in Rehn's first case.

Except in those cases in which it was performed on account of caries of the vertebræ (Treves, Schäffer, Aufrecht, Vincent, and others), this operation has been performed on the living subject in only a few cases. Rydygier operated on the right side in a case in which after removal of cervical lymph-glands an abscess developed into the posterior mediastinum. He was successful in separating the pleura (as was true when Obalinski and the author operated on the cadaver). Up to the present time there has not been a single case of acute abscess cured by posterior mediastinotomy (Cavazzani operated in a case of chronic abscess).

In order to reach the œsophagus, Rehn, Forgue, Henle, and Enderlen operated upon the right side; Llobet, on the left side. Rehn and Forgue operated below the arch of the aorta, the former in a case of stricture due to swallowing sulphuric acid and of carcinoma, respectively; the latter, in a case in which a large copper coin had been swallowed. In all 3 cases the operation was interrupted by dangerous symptoms. Rehn was successful only in his second case; both patients died as a result of the operation. After unsuccessfully performing mediastinotomy Forgue finally removed the coin through the mouth with a Gräfe's coin-catcher. Llobet, after resecting part of the fourth to the eighth rib on the left side, divided a cicatricial stricture of the œsophagus (22–26 cm. from the teeth); death resulted from

mediastinitis and pleuritis. The cases operated upon for foreign bodies have already been discussed. Except in the case of Forgue, in which the operation was interrupted, the pleura was almost always injured, either during resection of the ribs, during its separation, or subsequently by the sharp edges of the ribs. Of the 5 cases operated upon with the object of sufficiently exposing the œsophagus (Rehn, 2; Henle, Llobet, and Enderlen, 1 each), all except the last died as a result of the operation.

Till further experience has been gained, this operation, which is in itself serious, and which is almost sure to be followed by pyopneumothorax, is principally justifiable in abscess of the posterior pleural cavity following perforation of the pharynx and œsophagus, as it may certainly be expected that in some cases this operation may prevent an otherwise certain fatal termination. In the presence of foreign bodies the latter could be removed from the œsophagus or from the periœsophageal tissues by incision, or in case of perforation into the pleura they could be removed from the latter. At the same time any existing purulent ichorous exudation into the pleural cavity could be removed at once by incision.

CHAPTER IV.

DISEASES OF THE ŒSOPHAGUS.

INFLAMMATORY PROCESSES OF THE ŒSOPHAGUS.

Acute catarrhal inflammation of the œsophagus, which may be caused by irritation of the mucous membrane by foreign bodies, scalding, or irritating substances, is characterized by moderate mucoid secretion. Where inflammation is more severe there may be loss of epithelium, resulting in superficial erosions and ulcers, which usually heal without causing any complications.

Chronic catarrhal inflammation of the œsophagus occurs in alcoholics, also as a result of irritation caused by food accumulating in the dilated portions above the stenosis, in cases of diverticulum and carcinoma, also in the form of a congestive catarrh in chronic cardiac diseases. It is characterized occasionally by hyperæmia, leading to ectases, and marked thickening of epithelium. On œsophagoscopic examination there are seen a whitish cloudiness and a loosening of the mucous membrane, which secretes a mucoid, sticky substance; occasionally also there is slight dilatation of the œsophagus. In certain cases there occur circumscribed papillary proliferations as well as flat ulcerations; more rarely there are deeper ulcers. Where the inflammation continues for some time there may be thickening of the mucosa and the muscular coat (seldom leading to actual constriction); in other cases there are relaxation of the muscle and diffuse dilatation of the œsophagus. (Zenker-Ziemssen.)

Catarrhal œsophagitis may occasionally be followed by swelling of the follicles and result in a *follicular œsophagitis;* or if followed by dilatation of the follicles, small abscesses may occur, and by confluence of the latter *phlegmonous œsophagitis* may develop.

Croupous, necrotic, and **diphtheritic inflammation of the œsophagus** possesses surgical interest in so far as deposits of fibrinous pseudomembrane or dense infiltrations of the mucous membrane have been observed in the œsophagus; also in rare cases true diphtheritic ulcers, with subsequent cicatricial formation, occurring after extension from the pharynx or associated with acute infectious diseases (typhoid, measles, scarlatina, smallpox, sepsis, diphtheria, etc.). Such stricture formations have been recently observed, particularly after so-called diphtheria. (Leube-Panzaldt, v. Eiselsberg, Ehrlich, v. Hacker.) In the three last-named cases the stricture was always situated near the level of the bifurcation. In the author's case and that of Ehrlich it was particularly difficult to dilate the stricture.

The occurrence of thrush should not be confused with diphtheria; it occurs most frequently in children, but occasionally is met with in adults who have become exhausted by disease. In these cases it usually extends from the mouth and forms a yellowish or grayish-white deposit. In rare cases this may extend beyond the deeper layers of epithelium and invade the bloodvessels (E. Wagner), and may even produce metastases in the brain (Zenker). Where the disease is absent from the mouth the diagnosis may be determined by microscopical examination of particles adhering to the fenestrum of the stomach-tube. According to the case, mechanical cleansing of the œsophagus, or in case of stricture irrigation of the œsophagus with a 3 per cent. solution of borax, is effective in curing the disease. (Aufrecht.)

Phlegmonous inflammation of the œsophagus, first fully described by Zenker and Ziemssen, involves the submucous tissues, and like phlegmonous gastritis is very rare. This purulent inflammation may be circumscribed or diffuse, extending over large areas. If the collection of pus ruptures into the mucosa, complete recovery may take place where the abscess is small. Large abscesses may cause bulging of the mucous membrane over extensive areas, and then produce a sieve-like perforation of the latter, resulting in the formation of a phlegmonous ulcer. The abscess cavities may in part remain and be covered over with epithelium from the edges of rupture.

The disease occurs after injury by penetrating foreign bodies, fish-bones (Belfrage and Hedluins), and injuries caused by caustics (sulphuric acid), extension of abscess of the stomach, most frequently, however, by rupture of peri-œsophageal abscesses (glandular, vertebral abscesses, perichondritis of cricoid cartilage, etc.). If in addition these abscesses rupture into the larynx or trachea, there may be produced communication with these organs, and after the process has subsided permanent fistulæ may remain. The occurrence of phlegmonous œsophagitis was also observed in a case of laceration of the mucous membrane following violent vomiting (Voigt), and in one case without evident cause. It is of interest that in this disease there is no tendency for pus to rupture into the mediastinum with the production of progressive ichorous necrosis, or rupture into the pleural cavity, as so frequently occurs after perforation of the œsophagus.

Symptoms.—The symptoms vary: fever, chills, difficulty in swallowing, pain over the course of the œsophagus, particularly behind the sternum and radiating to the back, nausea, depression, cough, occasionally regurgitation of pus where rupture has taken place. These symptoms will render diagnosis possible only in case a foreign body has become impacted.

Treatment.—While ordinarily the treatment can only be symptomatic, under the last-mentioned circumstances œsophagoscopy may be of therapeutic importance. By the aid of this method a bulging abscess can be punctured and incised or the mucous membrane divided where it has become separated. In evidence of this fact is the author's experience. By means of œsophagoscopy an embedded piece of bone

was removed after the surrounding mucous membrane had become separated by an accumulation of pus. Immediately after removal of the foreign body pus escaped from the opening, followed by gradual recovery of the patient.

Toxic Œsophagitis.—Toxic or corrosive œsophagitis occurs after the ingestion of caustic chemical substances, and from a surgical point of view is the most important inflammation of the œsophagus on account of its complications, particularly the formation of strictures. At the same time there is usually erosion of the mouth and pharynx, frequently also of the stomach. Scalding fluids may act in the same way. Where the effect of the caustic substance is only superficial, the epithelial layer is thrown off either in patches or circular portions without further consequences. Where the formation of a slough involves the entire thickness of the mucosa and part of the muscular coat, the border of necrosis is marked by a line of purulent inflammation which may occasionally develop beyond the region of the œsophagus, setting up peri-œsophageal abscesses extending into the mediastinum with or without perforation, or leading to pleuritis, pericarditis, etc. After rupture into the respiratory passages œsophagobronchial fistula or tracheal fistula may develop. The ulcer undergoes cicatrization after the slough has been thrown off. As a result of contraction of the scar stricture is produced, which varies in length and degree according to the extent and depth of the lesion.

Swallowing concentrated solutions of the alkalies or sulphuric or nitric acid is as a rule fatal, principally on account of the extensive sloughing of the stomach, which in sulphuric acid poisoning leads directly to perforation. Cases of toxic œsophagitis applying for treatment are therefore usually such as have swallowed weaker solutions, particularly those of the alkalies used for household purposes. In most instances poisoning is accidental; occasionally the alkalies are taken with the intention of committing suicide. In children the mortality is usually high if the œsophagus and entrance of the larynx have been severely burned even where only small quantities have been swallowed, the cause of death being a subsequent inflammation of the respiratory passages.

Treatment.—The treatment of toxic œsophagitis is principally symptomatic at first: ice, fluid diet, feeding by the rectum, narcotics, stimulation. In very severe cases, which frequently die within twelve to twenty-four hours as a rule of perforation, which injury has extended over the surface of the stomach or œsophagus, little can be hoped from operation (laparatomy in perforation of the stomach, duodenostomy where there is severe injury of the stomach). Maydl's proposal to perform gastrostomy immediately in case of recent injury by caustics is worth considering. In the author's opinion this operation should not be performed in very severe or in very mild cases. In those cases which run a more chronic course, in which in the beginning the degree of injury is still doubtful, operation is indicated as soon as dead tissue has been thrown off from the œsophagus.

This process always leads to ulceration and the formation of extensive contractile scars. If as a result of the action of caustics or ingested food upon the ulcerated areas there are acute swelling and contraction of the muscular coat, and as a result of the latter more or less complete closure of the œsophagus, gastrostomy is urgently indicated. This applies also to cases in which there is perforation of a peri-œsophageal abscess, which can be recognized by the repeated regurgitation of pus mixed with blood. The œsophagus should be prevented from sustaining further injury by feeding through the gastric fistula.

Examination with bougies should certainly not be undertaken as long as there are manifestations of recent ulceration (fever, traces of blood in the saliva or in the vomitus). Such ulceration usually continues for from three to four weeks after the injury according to the degree of the latter. After this period, as a prophylactic measure, sounds may be passed into the œsophagus and left in place for a time; bougies may be passed through the mouth or soft drainage-tubes inserted by means of a piece of silk passed from the mouth to the gastric fistula. This procedure should not be continued for more than a few hours, having the portion of the œsophagus behind the larynx free in order to prevent pressure-necrosis. Even here great care should be taken.

Œsophagotomy is seldom permissible during the inflammatory stage following injuries from caustics. This operation would be indicated only in the presence of peri-œsophageal abscess; but even then it would be desirable, as Tietze has pointed out, to establish a gastric fistula.

ULCERS OF THE ŒSOPHAGUS.

Besides the catarrhal, diphtheritic, phlegmonous, and corrosive ulceration, discussed above, must be mentioned gangrenous ulcers caused by pressure, syphilitic and tuberculous ulcers, as well as peptic or round ulcers of the œsophagus. Ulcers caused by foreign bodies or carcinoma are discussed elsewhere.

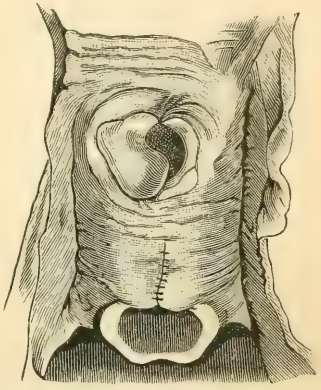
Gangrenous ulcers may be caused by pressure from within or without. Struma or some other tumor may press the cricoid or one of the tracheal cartilages against the œsophagus so that one or both walls of the latter may become ulcerated. The same effect may be produced by aneurism of the descending aorta, the latter rupturing after the slough has been thrown off. Foreign bodies act in the same way from within, particularly tubes left in place for some time. Most frequently the latter cause ulceration situated on the anterior wall behind the cricoid cartilage, similar to the so-called decubital ulcer. Perichondritis and necrosis of a portion of the cricoid cartilage may ensue, and after the latter has been thrown off, the mucous membrane may be drawn into the defect, causing the formation of a small diverticular recess usually situated at a typical site behind the cricoid cartilage. (Fig. 17.) More rarely there is produced ulceration of the posterior wall at a point opposite the cricoid cartilage or at both

sites. In exceptional cases (if stomach-tubes, etc., are left in place for a long time) ulceration may also occur at the two other sites of constriction of the œsophagus (bifurcation, hiatus, Kermanner).

In case of decubital ulcer, *κατ'ἐξοχήν*, there is produced on opposite points of the anterior and posterior walls of the pharynx an ulceration the size of a dime; at the bottom of the anterior ulcer the cricoid cartilage may be exposed; at the bottom of the posterior ulcer the body of the vertebra. Usually this form of ulcer occurs shortly before death in patients very much run down by disease, who constantly assume the dorsal position, and is caused by pressure of the plate of the cricoid cartilage, upon the folds of mucous membrane.

Syphilitic ulcers may occur in the œsophagus (Virchow, West, Klob, and others); they are very rare, and as a rule affect the upper portions of the œsophagus and the lower portions of the pharynx (Hermann). Exceptionally they affect the lower portion of the œsophagus. Frequently, cicatricial contraction in the pharynx obstructs the entrance of the œsophagus. This may also be produced by the formation of folds. The author made an œsophagoscopic examination in such a case at Prof. Neumann's clinic in Vienna. Mraczek has described such a case. In the majority of cases the lesion is a gumma bringing about constriction either through fibrous contraction or ulceration and formation of scars. In a number of cases the diagnosis was only made by noting the effect of antisyphilitic treatment. In a case of gumma of the entrance of the œsophagus, reported from Mikulicz's clinic (Gottstein), the diagnosis was made by the aid of œsophagoscopy.

FIG. 17.



Diverticular recess following gangrenous ulcer and necrosis of the cricoid cartilage. (Author's observation.)

Tuberculous Ulcer.—The occurrence of tuberculous ulcers of the œsophagus has recently been positively confirmed. These ulcers, associated with extensive tuberculosis of other organs, do not always produce symptoms (Mazotti); occasionally they run their course accompanied by pain and difficulty in swallowing. As a rule they are superficial, and as such rarely lead to constriction. Beck described a case, however, in which a diffuse ulceration, advancing from the pharyngolaryngeal portion of the gullet, was diagnosticated during life as carcinoma, and resulted in marked constriction; a similar case was described by Zenker. Most frequently, according to Zemann, stenosis results from rupture of cheesy glands into the œsophagus. (Weichselbaum, Beck, E. Frerichs, and others.) In such cases stenosis is caused more by the formation of scars and diverticula than by the occurrence

of tuberculous ulcers. More recently cases associated with carcinoma have been observed. (Lubarsch, Pepper, and Edsall.)

Actinomycosis.—It is only recently that cases of actinomycosis of the œsophagus have been described. In this disease infection takes place at a site where the epithelial covering has been destroyed by wounds or ulcers. The disease is certainly rare, and where the neighboring structures (soft parts of the neck, lungs, etc.,) are involved, it is difficult to determine the point of entrance. The involvement of neighboring organs, particularly the formation of abscesses and fistulæ in the neck, as well as the characteristic bodies in the pus, will render the diagnosis positive. In Mikulicz's clinic this was determined by examination of sections obtained by the aid of œsophagoscopy, in a case of stenosis with ulcerating tumor situated 26 cm. from the teeth, which had been mistaken for carcinoma. According to the conditions present, the treatment consists of incision, scraping, and administration of potassium iodide, sodium iodide, or of internal medication alone.

Peptic or Round Ulcer of the Œsophagus.—The occurrence of these ulcers, analogous to round ulcers of the stomach, and frequently observed at the same time as the latter form of ulcer, has been confirmed by a number of recent careful investigations. (Quincke, Chiari, Zahn, Debove, Lindemann, Ewald, Huwald, A. Fränkel, and others.) They occur only in the lowest portion of the œsophagus, being caused by the repeated action of the acid gastric juice upon portions of the œsophageal wall whose circulation has been impaired. The presence of Schaffer's heterotopically developed gastric glands was confirmed in Fränkel's case, but they possess little etiological significance and are of rare occurrence. Either they produce no symptoms or the latter are similar to those of gastric ulcer. They may give rise to profuse hemorrhage or to perforation. Perforation rarely takes place suddenly, but usually as a result of infiltration of the connective tissue caused by chronic inflammation, with formation of cavities in the mediastinum, from which site it may lead to inflammation of the neighboring organs, pleuritis, pericarditis, or even rupture into the pleura (pyopneumothorax), into the lungs (gangrene), into the trachea or the bronchi (bronchitis putrida), and possibly the formation of a fistula, or into the aorta with fatal hemorrhage.

Finally, cicatrization of round ulcer may lead to constriction, which may easily be mistaken for carcinoma (Quincke, Reher, Debove), or to the formation of pockets or valves; on the other hand, however, complete recovery may follow. Clinical diagnosis can only be made by means of œsophagoscopy.

It may be remarked that in rare cases simple round ulcer of the stomach when situated close to the cardia may extend to the œsophageal portion of the latter and bring about severe hemorrhage (K. Zaleski); also that as a result of cicatrization stricture may result extending to the œsophagus (Zenker and Ziemssen).

STRICTURE OF THE ŒSOPHAGUS.

Etiology.—The most important constrictions of the œsophagus are those caused by diseases of the wall of the œsophagus, and which are strictures in the true sense of the term.

From the point of view of differential diagnosis, those forms of narrowing of the œsophagus are important which are caused by penetrating bodies (foreign bodies, thrush, neoplasms, polyps, etc.), so-called *obstruction stenosis;* also that form of narrowing must be considered which results from pressure of enlarged or displaced neighboring structures, so-called *compression stenosis.* The latter may be caused by neighboring lymph-glands, usually those that have undergone cheesy degeneration, particularly those of the bronchi and the mediastinum, also tumors of the thyroid glands, aneurisms, enlargement of the cartilages, curvature of the spine, pleuritic and pericardiac exudate, mediastinal tumors and abscesses, etc.

Obstruction stenosis is considered under foreign bodies and neoplasms ; compression stenosis, in the differential diagnosis of strictures.

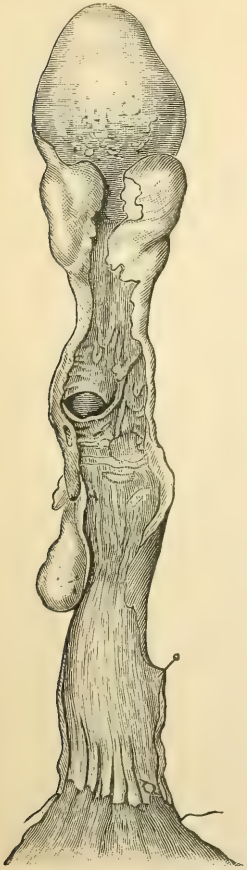
Of actual strictures of the œsophagus, those caused by carcinoma are the most frequent, and next in frequency those due to contact of caustics. All other causes producing stricture, including especially other inflammatory and ulcerative processes, are comparatively rare. Strictures caused by the swelling which is present during the acute stage of these inflammatory processes are called inflammatory, while those arising from contraction and subsequent constriction during the process of repair are called cicatricial strictures. Of 270 patients suffering from diseases of the œsophagus treated in the outpatient department of Billroth's clinic, from the year 1877 to 1886, 48.5 per cent. were cases of carcinoma, and at least 17.7 per cent. were strictures caused by caustics. Of the cases with œsophageal diseases treated in the hospital during the same time, 55.2 per cent. were cases of carcinoma, and 27.6 per cent. cases of stricture caused by caustics, and both diseases were associated (v. Hacker) in 82.8 per cent. of the patients.

Pathological and Anatomical Relations.—In discussing the pathological and anatomical relations of cicatricial strictures the author will consider strictures caused by caustics as the type, the remaining forms of cicatricial stricture being discussed under differential diagnosis.

According to the depth and extent of destruction, the strictures vary in form. Where the action has resulted only in a superficial destruction of epithelium the mucous membrane remains intact after the latter has become regenerated. But even in the milder cases there is usually necrosis of the mucosa, and occasionally of the submucosa, followed by subsequent scar formation, the latter either in itself or by retraction of the neighboring mucous membrane producing trabeculated (linear), crescentic, or valvular (semilunar) and annular strictures. These strictures, caused by superficial scar formation, are called "superficial strictures". Examples are shown in Figs. 18 and 19.

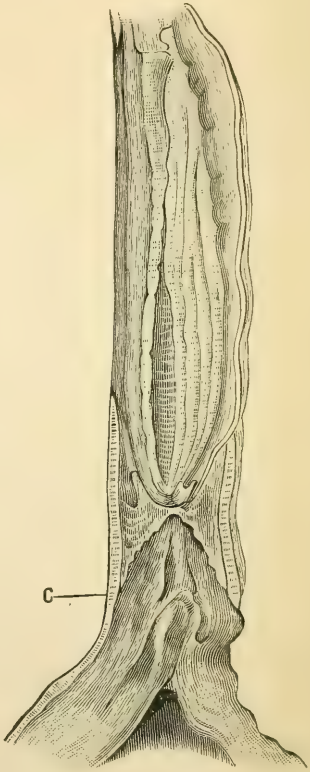
More frequently necrosis extends to the deeper tissues involving the muscular coat, the inner or both muscular coats being traversed by scars. There may even be indurated swelling extending beyond the œsophagus into the peri-œsophageal tissues, or a knuckling or displacement of the œsophagus from its proper course.

Fig. 18.



Valvular stricture above the bifurcation. (v. Hacker.)

Fig. 19.



Annular cutaneous stricture 1 cm. above the cardia (C), following cauterization with alkali. (v. Hacker.)

Through such scars affecting the deeper tissues callous strictures which involve the entire circumference are produced. According to whether they are more than 2 or 3 cm. long or extend over more than 5 to 10 cm. of the œsophagus, they are called annular or tubular strictures. (Figs. 20 and 21.)

Above annular or tubular strictures which cause considerable obstruction muscular insufficiency may result in dilatation, particularly if, as is frequently the case, the walls have undergone cicatricial

transformation. (Figs. 20 and 21.) Occasionally this change is only superficial. Frequently dilatation is only relative, the lumen not being abnormally increased.

Hypertrophy of the muscular coat, particularly of the circular fibres, occurring as a result of stenosis, is most marked in cases of long

FIG. 20.

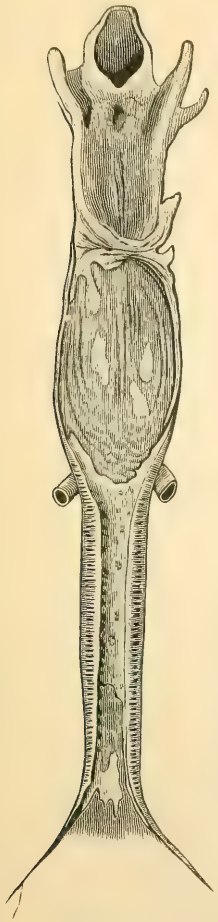


FIG. 21.

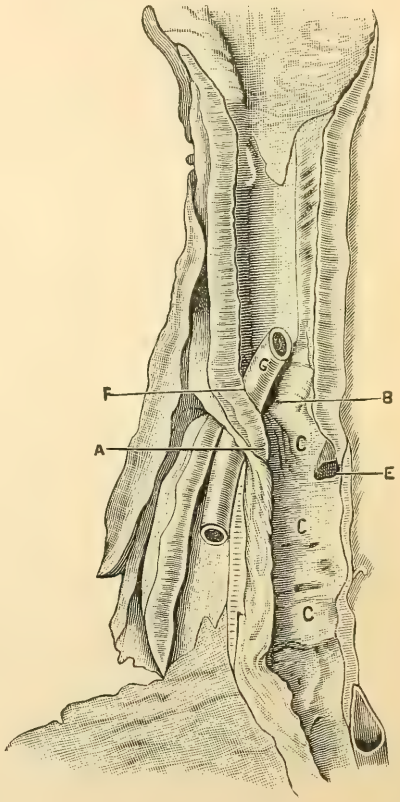


FIG. 20.—Typical tubular stricture in an adult, extending from the region beneath the bifurcation to the cardia. (v. Hacker.)

FIG. 21.—Typical false passage (C, C, C) situated in the right wall of a tubular stricture, arising in the thoracic portion and at the same time forming the prolongation of the œsophagus. G, tube showing the course of the œsophagus twisted at F. E, incision of internal œsophagotomy in the false passage, separated from the œsophagus by the spur A.

tubular strictures immediately above the narrowest point of the latter, and gradually diminishes above and below as a rule. As a result of this hypertrophy of the muscular coat and the continuous contraction of the latter the stricture may be increased in length above and below, so that at those sites where the mucous membrane is normal or super-

ficially altered the œsophagus appears as much constricted as at the site of the real cicatricial stricture. Such contractions certainly occur in recent cases as a result of inflammatory irritation, being accompanied at the same time by swelling of the scar. This occasionally happens after too energetic use of sounds. These strictures respond most readily to treatment by dilatation. Hypertrophy of the muscular coat is most marked in cases of typical tubular stricture of the portions of the œsophagus situated below the bifurcation. These strictures frequently extend from the level of the bifurcation to the diaphragm; in other words, they occur in that portion of the œsophagus in which the circular fibres are most highly developed under normal conditions. (Figs. 20 and 21.)

The most marked and the most extensive narrowing is always produced at that portion of the œsophagus where destruction was most severe. Although strictures can occur at any part of the œsophagus, they are most liable to occur at the site of the three natural constrictions of the œsophagus; at the entrance of the latter, at the level of the bifurcation of the trachea, and in the region of the hiatus œsophageus. Short annular strictures are located at these sites, as are also the centres of longer tubular strictures, from which points the latter extend upward and downward. (Figs. 20 and 21.) Accordingly as they are situated at the hiatus, the beginning, or the level of the bifurcation, there may be a combination of superficial and callous stricture. In this way there may be produced multiple strictures, or by a confluence of a number of extensive strictures total stricture of the œsophagus.

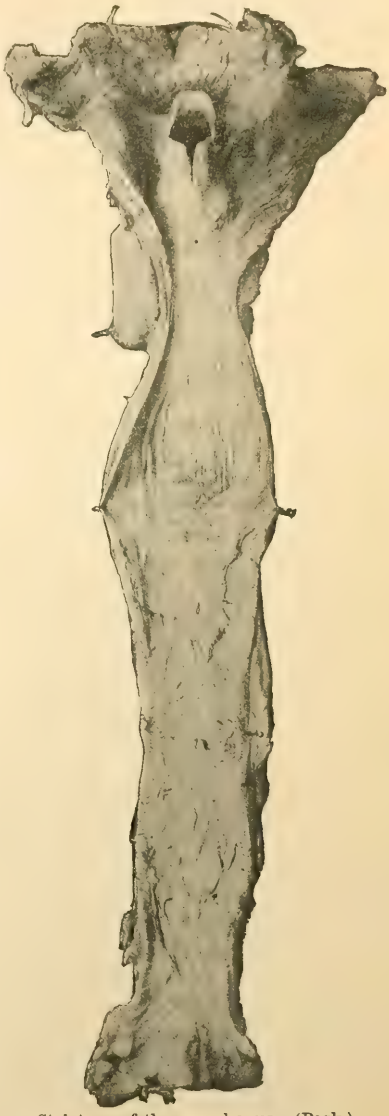
The accumulation of fluids from the region of the hiatus upward as a result of the closure of the œsophagus toward the stomach during swallowing, and the intermittent entrance of swallowed food into the stomach several seconds after the act of swallowing, is of great etiological importance. Large quantities of caustic substances remain in this situation a short time till they are propelled onward by peristalsis. In this way may be explained the occurrence of annular or tubular strictures, the latter extending upward for a variable distance above the cardia (v. Hacker), as has been typically observed especially in adults. (Figs. 20 and 21.)

In tubular strictures of the lower thoracic portion the narrowest part of the constriction is usually situated at the lower end. In tubular strictures extending along the superior thoracic portion or up to this portion the narrowest portion may be situated at or above the middle of the œsophagus. The dilatation which in the course of time is developed above the stricture, and which is occasionally formed at the expense of the length of the constriction, takes place from above and extends to the narrowest portion of the constriction, but does not extend beyond this point. In this way it happens occasionally that the line of transition between the dilatation and the tubular constricted portion, forming a projecting cicatricial ring, appears hypertrophied, being sharply marked above, and gradually passing into the deeper

portion by a number of radiating processes. In such cases sounding through the stomach may occasionally be easier than from above.

Practically it is of importance that the dilated portion, as well as the site of transition into the stricture, is frequently found in an inflamed and suppurating condition as a result of accumulating food, and that the rough, sacculated depressions, clefts, and trabeculæ of the inner wall may lead to the formation of ulcers, diverticula, inflammatory softening, peri-œsophageal abscess, or external perforation. Spontaneous perforation and perforation by bougies are frequently predisposed by sacculations of the wall above the stricture, or by the same condition in tho course of the stricture.

Fig. 22.

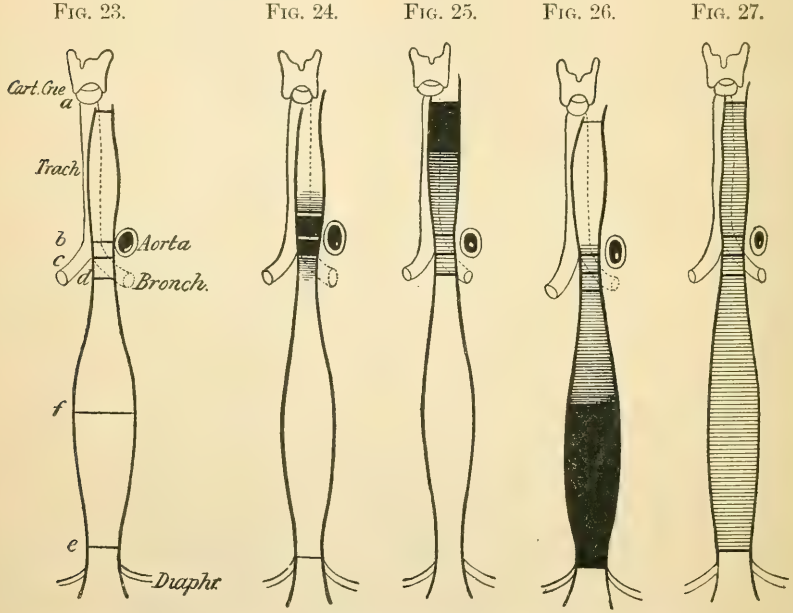


Stricture of the œsophagus. (Park.)

In all forms of stricture in which cicatricial tissue extends into the peri-œsophageal connective tissue, particularly in tubular strictures of the lower thoracic portion, the œsophagus may become adherent, fixed, twisted, and displaced from its proper course. This may occur at the site of transition from the dilated portion to the stricture, so that the lumen of the entrance of the stricture appears laterally displaced, and not in the direct prolongation of the canal. Displacement may occur at any point in the course of a long tubular stricture. This condition predisposes to the impaction of foreign bodies, the occurrence of false passages, or perforation by sounds.

If dilated, the false passage may form the direct prolongation of the œsophagus, or be mistaken for the latter when passing sounds, or, as in the case operated upon by Billroth, illustrated in Fig. 21, when performing internal œsophagotomy. According to the author's observations, there are two sites where in the course of tubular strictures false passages frequently arise: in the upper thoracic portion, on the left wall of the œsophagus, at the point where it turns from the left to the right side of the thorax, at the level of the bifurcation; in the

lower thoracic portion, on the right wall where the œsophagus turns from the right to the left side above the diaphragm. False passages frequently extend downward as far as the diaphragm. In general they rise more frequently from the stricture itself than from the dilatation above the latter. This is perfectly conceivable, as before entering the stricture the sound can still be more carefully guided. If the sound is firmly held by a cicatricial ring, it is frequently difficult to recognize when it is advancing through a false passage. Blood adhering to the sound may come from injured granulations. Pain may be present in both instances.



Schematic representation of the typical forms of stricture following ingestion of corrosive substances.

Fig. 23.—Sketch of normal œsophagus with the usual sites of circular stricture marked by lines *a*, *b*, *c*, *d*, *f*, and *e*: *a*, end of cervical portion; *b*, region of aortic arch; *c*, bifurcation of trachea; *d*, crossing of left bronchus; *e*, lower narrowing (at or somewhat above diaphragm); *f*, unusual stricture at a place between diaphragm and left bronchus.

Fig. 24.—Scheme of circular stricture of upper thoracic portion extending above and below bifurcation.

Fig. 25.—Scheme of tubular stricture of the cervical portion.

Fig. 26.—Scheme of tubular stricture of lower thoracic portion. The extent of the stricture is here, as in Figs. 24, 25, and 27, indicated by shading.

Fig. 27.—Scheme of stricture of whole œsophagus.

Symptoms.—Difficulty in swallowing is present in all constrictions of the œsophagus. In general it corresponds to the degree of constriction. Where constrictions develop slowly it gradually increases; but where stenosis occurs suddenly, as in case of obstruction, it sets in at once, so that if situated high up fluids swallowed instantly flow back out of the mouth and nose. If situated lower down, they will be vomited or regurgitated after a short time. Where narrowing develops slowly, it is a characteristic symptom that patients are careful

to take only a small amount of food at a time, that they swallow slowly, gag, and at times carry out certain motions with the head. If, however, a dilatation has developed above the stricture, the symptoms may be like those in case of diverticulum, food remaining some time in this portion being regurgitated later. Frequently the patients do not know whether food or even fluids have reached the stomach. Where the changes are marked, mucus and swallowed saliva accumulate, so that the patients are annoyed by a constant regurgitation of mucous fluid, and frequently also of tough, stringy mucus, particularly after attempts at eating. Generally fluids and soft food are more readily swallowed, but this is often not the case. Patients therefore thoroughly moisten the food with saliva or swallow fluids after taking solid food, etc.

As a rule, in cases of constriction there are marked temporary variations in the degree of difficulty in swallowing. These occur after inflammatory processes accompanied by ulceration, especially after injuries caused by caustics. During the acute stage of these processes, which are frequently manifested by regurgitation of blood, bloody mucus, pus, etc., there is usually dysphagia, which is generally accompanied by severe pain. After the ulcers have healed the difficulty in swallowing disappears for a time, recurring later when cicatricial contraction takes place and the stricture develops. Frequently this happens months afterward, and may be more severe than during the previous attacks, progressively increasing in the course of time.

Frequently patients locate the stricture incorrectly ; they may refer it to the region of the sternum and cricoid cartilage when it is located in the lower thoracic portion. Marked cicatricial stricture caused by caustics may produce a condition of extreme emaciation and inanition.

Diagnosis.—The diagnosis of the presence and seat of a stricture can be determined by examination with bougies.

As a rule, a solid English flexible bougie is employed for this purpose, occasionally also a whalebone staff or a stomach-tube. It is advisable in most cases to pass first a thick cylindrical bougie, and then successively thinner ones. In this way it is possible to determine at what distance from the teeth a sound which ought to pass through a normal œsophagus is stopped, and what size bougie can pass the stricture, or that the latter is not passable for the smallest sound or even the thinnest gut-string. If a number of strictures are present, the second or third, situated lower down, may be recognized at once or frequently only after the upper stricture has been dilated. Valves, folds, and pockets may offer no obstruction to larger bougies which dilate the canal, while smaller bougies are caught by the former. It may be determined also that the obstruction is caused by stricture, and not by some other condition, and it is frequently possible to recognize that the sound is held by a circular pressure, or that a sound can only pass if a certain degree of force is exercised. In case of compression stenosis, on the other hand, one frequently receives the impression that as soon as resistance is overcome by continuous pressure no hindrance is

found in the wall itself. In cases of compression, moreover, a softer, easily flexible instrument will frequently accomplish more than a rigid one.

On repeated examination of a stricture one can determine in what direction, by what manipulations (turning, advancing and withdrawing, gliding along a certain part of the wall, etc.) the bougie can be passed along the right path through the stricture. Free lateral motion of the bougie before entering the constriction would point to dilatation above the stricture.

It is seldom possible to determine positively the length of the stricture with the bougie. It may be accomplished by measuring or reading off the distance passed from the moment the instrument enters the stricture till it has passed the latter. For the purpose of determining the length and form of a stricture various moulded sounds have been constructed. B. Holmes armed a sound with wax. This is also employed in a sound recently introduced by Kelling, which is intended to take an impression of the stricture. The sounds of Schrieber and Reichmann are also intended for this purpose, besides being used for the purpose of dilatation.

After it has been ascertained by means of a bougie whether and at what level stricture is present, œsophagoscopy may be employed for the purpose of obtaining information in regard to the details of the parts above the stricture, as well as the position of the entrance into the latter (eccentric displacement of the lumen), the appearance of the passage of the stricture, particularly, however, in regard to whether it is caused by a cicatrix or by carcinoma.

In well-developed strictures caused by caustics the œsophagoscopic findings are, as a rule, very characteristic. (v. Hacker.) In the cervical portion and the portion below the bifurcation there are frequently linear, longitudinal, and macular white scars, sharply raised above the red mucous membrane. Close to the stricture the mucous membrane is even more traversed by scars. An annular stricture or a commencing tubular stricture appears as a cicatricial funnel or like the vaginal portion of the cervix. It is only in case of very superficial scar formation that the constricted portion, which is often eccentrically displaced and frequently appears like a diaphragm turned in, shows respiratory motions and radiating folds. The deeper the action of the caustic, the more immovable does the constricted portion become. In the strictured portion one will find a canal partially or completely lined with white cicatricial tissue. While in carcinoma proliferation and infiltration are characteristic features, in cicatricial stenosis there are contraction and scar formation.

Differential Diagnosis.—The differential diagnosis between carcinomatous and cicatricial stricture is comparatively easy. In the great majority of cases of carcinoma a positive diagnosis can be made even in the early stages by means of œsophagoscopy, and frequently also by extraction of portions of tissue by means of the latter method and their microscopical examination. Without œsophagoscopy the

diagnosis can frequently be only a probable one unless possibly portions of carcinomatous tissue remain adherent to the bougie. In case of stricture caused by injury the history will be a guide; subsequently œsophagoscopy will be an aid to diagnosis.

In rare cases in which a stricture is not carcinomatous nor caused by caustics, one must consider cicatricial stricture following injury caused by a foreign body, or one of the inflammatory processes previously mentioned. As the strictures caused by the latter are more circumscribed and do not involve the deeper tissues to such a degree as to distort the neighboring mucous membrane, there is as a rule in these cases simply a superficial or valve-like stricture. These strictures are generally single. In cicatricial strictures the history is characteristic; also the above-mentioned temporary variation in the degree of constriction and the subsequent progressive increase. In the latter there is also the firm resistance offered to the sound by the cicatricial tissue; also the rapid response to treatment. In certain respects the site may be a guide in so far as in the lower part of the œsophagus one may think of stricture caused by peptic ulcer in the region of the bifurcation of the trachea, of cicatrization associated with cheesy degeneration and suppuration of the bronchial lymph-glands.

Stenosis of the œsophagus resulting from adhesion of the latter with cheesy, slaty, indurated lymph-glands situated at the bifurcation of the trachea, or from the formation of a traction diverticulum through cicatricial contraction, also permanent or temporary compression of the œsophagus, caused by enlarged glands, and finally also cicatricial strictures of the œsophagus resulting from abscess and rupture of lymph-glands, with cicatricial formation in the œsophagus, have been repeatedly observed. As a result of using too much force in passing bougies perforations may be produced in the spaces between the lattice-like cicatricial bands present in such strictures. As a result of suppuration of the wall there may be rupture into a bronchus. The erosion of vessels may lead to severe and fatal hemorrhage. (Krauss, Körner.)

In rare cases of stricture following peptic ulcer, or following ulcer of the cardia extending into the œsophagus (Eversmann), the diagnosis may be based on the location, the occurrence of hemorrhage if the ulcer is still open, and the severe pain felt at the moment of swallowing or a short time after, without actual interference with swallowing; also the protracted time required for the development of the stricture, as well as its occurrence in anæmic or alcoholic individuals.

Syphilitic strictures are more frequently met with in the upper portions of the œsophagus, and may be very extensive. Usually there are other symptoms of constitutional syphilis; also the response to antisyphilitic treatment. Diphtheritic stricture may be suspected following a previous diphtheria. In case of extensive strictures the scars of phlegmonous œsophagitis must be considered. Pure spastic stricture would be indicated by variable situation and varying intensity of the symptoms in nervous, hysterical individuals. Resistance to

sounds may apparently be as insurmountable as in cicatricial stricture. By means of œsophagoscopy it may be possible to determine the absence of any anatomical change in the wall. By the same method of examination it is possible to determine the principal causes of obstructive stenosis, namely, the constriction of the lumen by intra-œsophageal polyps, deposits of thrush, and foreign bodies.

Another form of obstruction which is important from the point of view of differential diagnosis is compression stenosis.

In the neck, thickening and ossification of the plate of the cricoid cartilage occurring without symptoms in old age may cause marked manifestations of constriction of the œsophagus. (Travers, Wernher.) In a similar manner marked compression stenosis in the neck can be caused by lordosis of the cervical portion of the vertebral column (Sommerbrodt), particularly where the lordosis of the cervical vertebræ compensates senile kyphosis of the dorsal vertebræ. (v. Hacker.) In the neck the œsophagus may also be compressed by struma encircling it in the form of a ring, or unilateral retrovisceral struma. This form of compression may also be confirmed by œsophagoscopic examination. Dysphagia is more severe in case of stenosis, which, according to Rose, is almost always present in malignant new growths of the thyroid gland, and which is caused by compression or direct invasion of the tumor. Carcinoma originating in the larynx, enlarged lymph-glands, and tumors of the cervical vertebræ may also cause constriction of the œsophagus.

In the thorax, as in the neck, neighboring tumors will produce stenosis of the œsophagus only where they completely surround or invade the latter, owing to the fact that the œsophagus is freely movable. Mediastinal tumors, carcinoma of the vertebræ, of the lungs or pleura, bronchial and mediastinal lymphomata (particularly tuberculosis and carcinoma) may be considered. Aneurism causes pressure stenosis only when there are adhesions with the œsophagus. Only in exceptional cases will marked hypertrophy of the heart, or marked pericardial or pleuritic exudate, cause dysphagia. On the other hand, dysphagia frequently results from large peri-œsophageal abscesses, also in cases of a pulsating diverticulum when the latter is filled.

Prognosis.—In regard to carcinomatous strictures see page 111. The chances of recovery in cicatricial stricture vary according to the extent and depth of the scar; for this reason strictures due to the action of caustics are usually more difficult to treat than those occurring after other inflammatory and ulcerative processes. On account of the tendency of cicatricial tissue to contract, strictures almost always recur, even after they have been successfully dilated, unless dilatation is regularly carried out afterward, for this treatment can never restore the normal elasticity. For this reason the number of complete recoveries is small. In children the prognosis is generally more favorable, as artificial dilatation is aided by the gradual growth of the œsophagus. (Keller.) This applies particularly to cases in which scar formation does not completely encircle the œsophagus. Following the

action of caustics the mortality is so great that those cases which do recover are generally those suffering from the milder forms. In general, of those patients which survive the immediate effects of the injury caused by caustics, one-third die from the consequences of the stricture. The prognosis is least favorable in cases in which the stricture involves larger areas.

As patients suffering from strictures are always liable to have a recurrence unless the stricture is regularly dilated afterward, and as frequently foreign bodies remain impacted in the beginning or in the course of the stricture, they are always exposed to the consequences of stricture or of the treatment necessitated by the latter. Many die of inanition or of tuberculosis. The most frequent cause of death in those treated by dilatation is perforation of the œsophagus, which may take place spontaneously as a result of ulceration, or, as is occasionally the case, rupture is predisposed by the presence of a foreign body and indirectly caused by the use of bougies. It may also be directly due to too much force in passing a sound or to the formation of a false passage, etc. It is important to note that in single instances even superficial epithelial abrasions and ulcerations without true perforation may be followed by peri-œsophageal suppuration and lead to death. According to its location, perforation is followed by pleuritis, pericarditis, mediastinitis or purulent bronchitis, gangrene of the lungs, etc. In those cases dying after operations perforation is not infrequently found to be the cause of death. Perforation is rarely caused by the operation as such (internal œsophagotomy), but generally by a previously existing ulceration.

The earlier treatment is instituted, the more favorable will be the results.

Occasionally dilatation permanently and completely removes the disturbance, even in apparently severe cases. In recent times the prognosis of apparently impermeable strictures has been materially improved by the treatment of the latter with sounds passed through the mouth or through an œsophageal fistula to the stomach fistula by methods in which the dangers of producing injury with the tip of the sound are obviated.

Treatment.—Except in those rare cases of stricture of the cervical portion in which attempts are made to divide the stricture longitudinally and to stretch the wound transversely, or in those cases in which the constricted portion is resected, strictures of the œsophagus are always treated by dilatation. According to the manner of carrying out the treatment and according to the route employed for this purpose, two methods may be distinguished:

1. Dilatation with sounds and similar instruments, which are passed through the mouth.

2. Operative treatment.

Dilatation Treatment.—As examination with bougies is necessary for the determination of the site, character, and degree of stricture, it would naturally suggest itself to leave in place for some time

the first sound that will enter or pass the stricture, in order to produce dilatation. Gradual dilatation, by passing bougies and similar instruments through the mouth, is therefore the method most frequently applied. Besides being employed in cases of actual stricture, it may also be successfully applied in many cases of stenosis caused by compression. In cases in which the stricture is not too tight, woven flexible bougies or woven flexible stomach-tubes are the most useful. These bougies, if softened or hardened by placing in hot or cold water, and lubricated with oil, vaselin, glycerin, or egg-albumin, will readily glide down if passed and advanced according to the rules given in describing the method of examination with bougies. These bougies may also be used by the patients themselves, provided they have been properly instructed as to the method of introducing them. The stomach-tube may be employed where, in cases of exhaustion, it is intended to feed the patient as soon as the stricture has been passed. Usually, however, the solid flexible woven bougies are employed, either with cylindrical or conical tips. In children flexible urethral bougies, particularly those with conical tips, are frequently employed. In case of moderate stricture the cylindrical bougies will answer the purpose. In tighter strictures the conical tipped bougies are employed. They more readily enter the stricture, but at the same time are more liable to produce injury. The cylindrical bougies are not employed until the stricture has been dilated to the size of a lead-pencil.

During the first attempt at passing a bougie it is impossible, as a rule, to leave the latter in place for more than a short time, as the patient usually gags and stops breathing. As soon as the patients have become accustomed to breathe regularly while the bougie is in place and allow the saliva to flow out of the mouth at the side of the bougie, the latter may be left in place for from five to ten minutes, or even one-quarter or one-half hour. Experience has shown that in the comparatively mild cases of stricture in which this method of dilatation is indicated it is sufficient to pass the bougie once or twice a day and allow it to remain in place a short time. Under normal conditions a bougie 13–14 mm. in diameter ought to pass the narrow entrance of the œsophagus without appreciable stretching of the walls. It is sufficient therefore in case of stricture to dilate till a sound of this size can easily be passed. In order to prevent the part of the bougie projecting from the mouth of the patient from being chewed, particularly in children, a piece of cork or a wooden wedge should be placed between the teeth.

In addition to woven flexible bougies there are woven bougies with a lead core (Rontier) or a core of mercury. The latter act partly by their weight, and have been recommended in certain cases by Billroth.

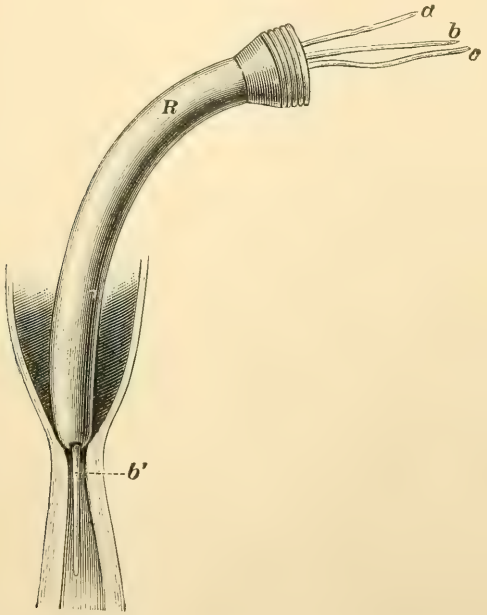
In very tight strictures the small-calibre woven flexible bougies, even if placed in very cold water, are not sufficiently stiff to pass through narrow constrictions. They bend when they reach the latter or are too large to pass through them. In such cases catgut strings are employed; they should be well rounded at the tip (but not frayed

out from frequent use). After having been passed into the constriction the gut swells, thus dilating the stricture. They may remain in place from ten to thirty minutes. Frequently it is possible to dilate very narrow strictures, particularly in cases in which the entrance is eccentrically placed, by passing a number of gut strings into a short hollow bougie which has been passed as far as the stricture (v. Hacker, Fig. 28), carefully advancing first one string and then another. This method was successfully employed by Eiselsberg.

As soon as a stricture has been sufficiently dilated with gut strings or small bougies further dilatation can be most rapidly and safely accomplished by introducing a drainage-tube drawn over a sound as a guide. (v. Hacker.)

The bougie, which should be well rounded at both ends, but particularly at its tip, is armed with a rubber drainage-tube in the following

FIG. 28.

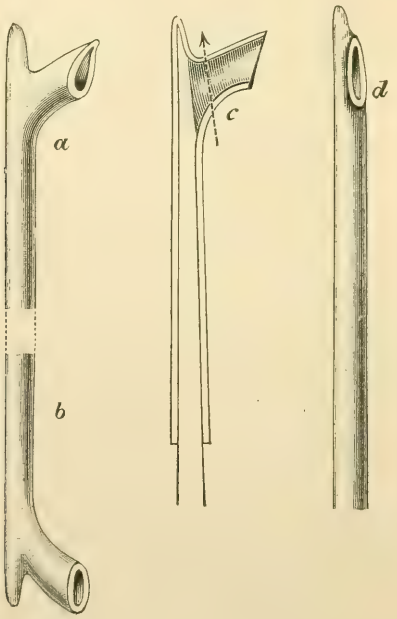


Passing thin gut strings (*a*, *b*, *c*) through a hollow bougie (*R*) into the stricture (*b'*).

manner : The bougie is well lubricated with vaselin, glyceriu, etc., the drainage-tube is then grasped at both ends and stretched sufficiently to project beyond both ends of the bougie, and by bending the tube over the tip of the sound and relaxing the tension on the tube the former will cause the walls of the tube to bulge. (Fig. 29, *a* and *b*.) Only that part of the tube projecting beyond the tip of the bougie need be cut off (Fig. 29, *c*) so as to enable it to be readily passed (Fig. 29, *d*). At the other end of the bougie the tube may project farther, or it may be tied off, to be clamped to the bougie by some special contriv-

ance. For a guide the author usually employs a new gut string covered with shellac to prevent it from swelling, or the smallest size flexible woven bougie stiffened by a core of copper wire. More rarely he employs a whalebone staff. The latter is less flexible, but for the same reason more liable to produce injury. If in passing the above instrument any obstruction is met, it is usually due to the fact that the tip is too sharp. As soon as the stricture has been passed, the drainage-tube is allowed to glide slowly along over the guide and the latter withdrawn from the tube. The drainage-tube contracts, assumes its former greater diameter, and in this way dilates the stricture. This method is so effective that strictures which hardly admit a bougie 4–5 mm. in diameter can be passed by a bougie 15 mm. in diameter after from two to three weeks. Care must be taken that the size of the tubes is increased gradually, as too large a drainage-tube

FIG. 29.



Dilating the œsophagus by means of a drainage-tube drawn over a guide.

may cause laceration of the œsophageal wall. If the tube is to be left in place for some time, it is easier to carry it out through the nose by means of a Bellocq tube than if a rigid bougie is used. It is also possible to feed the patient through the tube. The latter can be thoroughly sterilized by boiling.

The method described has been found useful in cicatricial as well as in carcinomatous stricture. In a series of cases in which, as a result of carcinomatous proliferation, the lumen had become so contracted that the patient could hardly swallow fluids, and they only in

insufficient quantity, the author found that after such a thin drainage-tube had remained in place during several hours on one or two successive days, or for one night, the patients could again swallow for weeks or months.

Besides the instruments mentioned above, various other sounds are employed in the treatment of strictures; thus, for example, whalebone sounds to the tip of which variously sized hard-rubber or ivory buttons can be screwed (Trousseau's sounds), also metal sounds with spherical tips (Rosenheim), block-tin bougies, etc.

For the purpose of gradual dilatation the passage of elastic tubes or bougies or gut strings (in certain cases olivary bougies), later dilating drains, and later still larger bougies, are most to be recommended. They accomplish all that can be hoped for in cases that are adapted to dilatation. Whatever method of dilatation is employed, it should be carried out with great care and gentleness, continued gradually, and immediately discontinued if it is followed by severe pain, stitch in the side, or fever, in order to avoid the occurrence of peri-œsophageal suppuration, perforation, etc.

Dilatation with dilatable instruments operated by springs intended to tear the stricture (dilators of Fletscher, Collin and Lefort, Vidal and Leube), also those which dilate more slowly (Jameson, v. Bruns, and Switzer), has been almost entirely discarded. More recently there have been employed dilating sounds of Senator (inserting a tent attached to a string by means of a bougie), dilatation by means of rubber tubes filled with water (Schreiber), and the sounds of Reichmann and Russel constructed on similar principles.

On account of the simplicity of the method and on account of the possibility of watching the amount of dilatation the author prefers the employment of a rubber drain drawn over a bougie to all the mentioned dilating instruments.

Dilatation through the mouth may be accomplished with the aid of the œsophagoscope.

The author first employed this method in 1888, and having used it a number of times since that time he has found that occasionally it is possible by the aid of œsophagoscopy to find the lumen with gut strings or thin, small-size bougies, and to pass a stricture that had hitherto seemed impermeable. In addition, it is possible to employ successfully his method of drawing a rubber drainage-tube over a guide, or by means of a guide to insert tents (solid, not hollow, owing to the uncertain amount of swelling of the latter). (Ebstein, Rosenheim, Pariser, Guttentag.)

According to the author's experience, there are not many cases in which the stricture can be more easily dilated through the œsophagoscope than by the usual method through the mouth. In his own cases of this kind he was able to pass the stricture after he had dilated once or twice through the œsophagoscope, and had ascertained the character of the obstruction. Cases in which this cannot be accomplished should be treated by operation.

For the purpose of aiding the dilatation treatment it has recently been recommended to employ thiosinamin internally on account of its power of softening scars. A 15 per cent. alcoholic solution was employed. Adults are to be injected with 5–10 lines of a Pravaz syringe, children with 2–3 lines, every second or third day. (A. Fränkel, E. Teleky.)

Operative Treatment.—As a transition from dilatation to operative treatment may be mentioned the use of caustics as well as electrolysis, for the purpose of dilating strictures.

At the present day the employment of caustics in the œsophagus is only admissible if carried out with the aid of the œsophagoscope. Caustics were first employed by the author for this purpose in case of fissures after injury, in case of superficial ulcerations, and in case of carcinoma. In addition to a brush or caustic-holder, a specially adapted galvanocautery may be employed. In cicatricial strictures this method could only be used for the purpose of dividing a bridge or trabeculum, or a cutaneous annular or valve-like constriction. Recently the author successfully incised a portion of an annular stricture projecting into the lumen by means of a hook-shaped cautery, and subsequently dilated it with drainage-tubes drawn over a guide.

Electrolysis is occasionally employed in fibrous or carcinomatous strictures. A spherical or conical metal sound attached to a stomach-tube, connected with the negative pole, is applied to the stricture, while the positive pole is applied to the thorax by means of a plate electrode. Lefort allows the current to act on different portions of the stricture alternately (Electr. linéaire), using in cicatricial strictures a current of 15 milliampères, each sitting lasting from fifty to sixty seconds; in carcinoma, 32 to 36 milliampères, each sitting lasting from ten to fifteen seconds. Böckel and others, using a correspondingly strong current, gently advance the instrument, which has previously been passed as far as the stricture. Many claim that this method is free from danger and successful in removing strictures. Others (Newmann) have not found it beneficial. Electrolysis has been employed, not only through the mouth (Lefort, Sletow, Postnikow, and others), but also through a gastric fistula (Hjort), or through an incision in the œsophagus, or through an œsophageal fistula (Pretorius).

Actual surgical operative treatment of stricture is employed when treatment with bougies is unsuccessful in spite of all the recent improvements in its technic. This is the case where a stricture is impassable or cannot be dilated sufficiently and without danger. The principle governing surgical treatment of stricture elsewhere, exposure of the site of the stricture, and division of the stricture, or complete excision of the latter, can only be applied to certain cases of stricture of the cervical portion of the œsophagus, owing to the great danger involved in exposing the thoracic portion (Rehn), or the cardial portion (Levy's, Biondi's, and Bozzi's experiments on animals). In all other cases an attempt must be made to approach as near to the stricture as possible in order to dilate the latter, if not under guidance of inspection,

on contracting, produce dilatation of the latter. In dilating from the mouth to the gastric fistula, as in the reverse direction, those drains may be left in the stricture for several hours, provided the precaution is taken to allow only the string to occupy that portion of the œsophagus from the mouth to the cricoid cartilage on account of the danger of pressure-necrosis of the laryngeal cartilage. Frequently it is sufficient to perform dilatation daily for half an hour with drains of increasing size. Where dilatation is kept up for such a short time the drainage-tube may be left in place behind the larynx and drawn out through the mouth. This will be necessary where the stricture is situated in the cervical portion. In removing the tube a strong thread is drawn after it. This is allowed to remain in place between the mouth and the fistula and serves as a guide. In case of strictures situated lower down it is most practicable to have the tube reach from below the cricoid cartilage, through the entire œsophagus and a short distance beyond the fistula. It is less safe to allow the drainage-tube to extend only through the cardia, as far as the stomach, for if the drainage-tube is engaged in the fistula, the thread may be torn by drawing on it.

According to the author's method, a fine, solid rubber cord is first drawn after the string, and then continually larger drainage-tubes. The lumen of the smaller drainage-tube is held open with forceps, and the next larger tube inserted in order to avoid any sharp increase in calibre. v. Eiselsberg employs a tapering rubber tube. Such a tube will not always be obtainable, however, and should always be boiled after having been used, while clean drainage-tubes are always at hand.

Similar to dilatation with drainage-tubes drawn in by strings is the method introduced by Weinlechner, and later by Maydl and Frank. By this method bougies are drawn through the œsophagus with a string; also by drawing increasingly larger ivory olivary bougies (Kraske), a tape provided with knots of increasing size (Soldani), or gut strings (Socin). In cases in which it is not possible to pass bougies from the mouth immediately after gastrostomy, as in cases of injury of the stricture canal, it is advisable, according to Socin, to have the patient swallow a buckshot with a string attached, a method which was formerly employed for the purpose of introducing Jameson's or v. Bruns' dilators. Kraske had the patient swallow a string with a knot in it. The string is then drawn out through the fistula with the finger or a small hook, or pushed out of the stomach by filling the latter with fluid. If Henle's probe-shaped magnet is obtainable, an iron ball can be swallowed instead of a buckshot, and be "fished" out of the stomach with the magnet.

After waiting for some time, and if in spite of repeated attempts, it is impossible by any method to render the stricture permeable, it is wise to perform temporary œsophagostomy according to Billroth's method, and then to carry out dilatation from the œsophageal fistula to the gastric fistula, or occasionally in the reverse direction. This method

has produced very good results in the hands of Billroth, v. Hacker, v. Eiselsberg, Mikulicz, Bernays, Pretorius, etc.

The method of dilatation usually renders a stricture passable for the largest size bougies within from three to five weeks. Others, desiring to obtain quicker results or wishing to divide a valve-like or diaphragm-like stricture, have employed Abbe's method through a gastric fistula in connection with gastrotomy, either through the mouth or through an œsophageal fistula. According to the level at which the stricture was situated, a large bougie was passed into the stomach either from above or from the stomach, and while the former was firmly held against the stricture, the cicatricial tissue was sawn through by drawing the string backward and forward. Immediately afterward large bougies were passed.

If, after establishing a gastric or œsophageal fistula, it should still be impossible in spite of continued attempts to pass the stricture, and if a thin partition should be found between the finger inserted through the stomach, or through the œsophageal fistula as far as the stricture, and the bougie passed through the other fistula, attempts might be made to crush or penetrate gradually through the partition. This is most safely accomplished with a sharp metal sound pressed against the inserted finger with gradually increasing force.

If the stricture is impermeable and situated so high up that it can be reached by the finger passed through the œsophageal fistula, and if it is impossible to pass a bougie upward through the cardia from the gastric fistula, the abdominal cavity may be opened near the fistula (at the same time preserving the latter), and by passing the hand into the abdominal cavity and searching for the crura of the diaphragm in order to guide the bougie after it has been passed through the fistula, the bougie being readily felt through the wall of the stomach.

If after establishment of a gastric fistula all the above-mentioned methods fail to render the stricture passable, the gastric fistula should be enlarged by dividing the tissues within the limits of its adhesions with the abdominal parietes. In one case Fischer was unable, with his finger passed through the cardia, to touch a steel olivary bougie passed through the œsophageal fistula. He allowed the fistula to remain for the purpose of providing nourishment. Such cases are infrequent. Owing to the difficulty of reaching the lower portions of the œsophagus with the finger passed through the gastric fistula,[1] it would be advisable in such a rare case immediately to perform laparotomy and to divide the stomach, as well as the fistula, within the limits of the adhesions, and to enlarge the opening in the stomach, proceeding in the same way as in primary gastrotomy. If by this method it were possible to perform retrograde dilatation, the opening in the stomach might be entirely closed and the fistula established at

[1] The distance of the cardia from the abdominal incision can be approximately determined by taking the diameter of the body (spinous process to the ensiform cartilage) and subtracting the distance from the spinous process to the anterior surface of the vertebræ (9-10 cm. in adults).

some other part of the stomach, providing further dilatation through a fistula should be required. This procedure would render primary union of the stomach more certain.

The new methods of dilatation of strictures with the aid of gastrotomy or gastrostomy are frequently and incorrectly called retrograde dilatation through the stomach. Except in those cases in which the operation is performed at one stage (gastrotomy), no retrograde dilatation is carried out, but dilatation guided by a string, for in the author's opinion retrograde dilatation through the cardia cannot be safely carried out from a well closing gastric fistula unless a string has been previously passed to serve as a guide. In cases of tight stricture in which dilatation from the mouth was impossible, this method was successful after a gastric fistula had been established.

1. A stricture may become passable some time after gastrostomy has been performed, and can then be dilated from the mouth by the usual methods.

2. Retrograde dilatation may be carried out from the gastric fistula.

3. A stricture may be rendered passable by one or both of the above-mentioned methods, the string guide method employed, and by means of the string Abbe's method (internal œsophagotomy with a string), or one of the methods of dilatation (v. Hacker), may be carried out.

4. Where gastrostomy has not been successful, temporary œsophagotomy may be performed (Billroth) and the stricture rendered passable from the œsophageal to the gastric fistula, or in the reverse direction, the string drawn through, and Abbe's method or dilatation carried out.

The establishment of a gastric fistula for the purpose of dilatation treatment of benign strictures has been found serviceable not only in case of strictures situated near the cardia and the thoracic portion in general, but also in strictures situated in the upper thoracic portion (Socin), or in the cervical portion (v. Eiselsberg, Winslow).

The methods of gastrostomy employed are described in the surgery of the abdomen. The author will only point out here that for the purpose of treating strictures a method of forming a gastric fistula is to be chosen in which an actual lip fistula is not formed—*i. e.*, in which the mucous membrane is not sutured to the outer skin—and a method according to which the fistula leads into the stomach without forming an angle. The first condition is desirable in order that no complicated or plastic operation will be necessary to effect closure of the stricture; the second condition is necessary for the convenient passage of bougies. The least adaptable method is that of Szabanejew-Frank. By Witzel's method of forming a canal and the modifications of the latter (Marwedel, Kader) the canal gradually becomes straightened and dilatation can therefore be carried out. The author's method of simply forming a sphincter from the rectus, which is absolutely safe if performed in two stages, has proved itself practicable not only in his own hands, but also in the hands of others. (Billroth, v. Eiselsberg, Narath, Körte,

Herczel.) In cicatricial strictures it was possible by this method to close completely the fistula with a drainage-tube. Recently the author obtained the same result by combining the formation of a sphincter with Lucke's method, the operation being performed in one stage.

In all cases in which simple dilatation with bougies through the mouth is impossible or does not continue to produce improvement, it is advisable to proceed immediately to gastrostomy, acting on the principle that repeated passage of bougies in a long, tortuous, and partially ulcerated stricture is more dangerous than skilfully performed gastrostomy. After the latter operation attempts should be made to render the stricture passable, either with or without the formation of an œsophageal fistula, and after that dilatation should be carried out.

DILATATIONS OF THE ŒSOPHAGUS.

By Dr. G. LOTHEISSEN.

Diffuse dilatation of the œsophagus occurs above a stenosis. The latter may be due to some anatomical change or may exist independently of anatomical change, as in nervous or spasmodic stricture.

Dilatation of the œsophagus occasionally may occur above a stricture, but is rare, because as a result of obstruction the muscular layer becomes hypertrophied and dilatation only occurs when the hypertrophied muscle becomes insufficient as a result of fatty degeneration, for example. (Klebs.)

Dilatation takes place above cicatricial stricture; also in cases of carcinoma (of the cardia, for example, where the lowest portion of the œsophagus may be dilated and still show muscular hypertrophy). (Reher.) The widest part of such dilatations is immediately above the stenosis (congestive ectasis, Zenker). They gradually become smaller above. In these forms dilatation is of little practical significance as compared with the stricture.

Jaffé described a peculiar form of stenosis leading to diffuse dilatation. The cardia was flattened between the xiphoid process, which was bent inward in the form of a hook; and one of the lower thoracic vertebræ, in a patient with marked kyphoscoliosis, the portion of the œsophagus above the stenosis was cylindrically dilated, having an internal diameter of from 10 to 11 cm. In addition there occasionally occur enormous dilatations not due to anatomical change. These diffuse ectases, formerly called idiopathic, are as a rule accompanied by spasm of the cardia (cardiospasm of Mikulicz). In another group of cases there is atony of the œsophagus. Such dilatations are frequently spindle-shaped. They may extend from the larynx to the cardia. Their greatest width (up to 30 cm. in circumference, Luschka) is generally about the middle of the œsophagus, or the latter may assume an S-shaped curve in consequence of dilatation (Mass); under such circumstances the dilatation has more the form of a wide cylinder. Some of these dilatations have been observed at an early age (ten years,

Mackenzie), and may be congenital (Zenker has found them in the newly born). Luschka has described a special form of the lower portion of the œsophagus, situated above the hiatus of the œsophagus (pregastrium) and between the hiatus and the cardia (cardiac antrum).

Most diffuse dilatations are acquired. Some disturbance of innervation must be accepted as an important etiological factor. It may happen that the function of the longitudinal fibres, whose contraction causes normal dilatation, is impaired and that consequently there is spasm of the cardia. (Rolleston.) This condition seems hereditary in certain families. Kraus emphasizes the coexistence of two factors: 1, failure of inhibitory influences on the cardia (disease of the vagus nerve); and 2, permanent relaxation of some portion of the muscular layer of the œsophagus. Through the preponderance of one of these factors are obtained the two mentioned types of dilatation of the œsophagus.

Diffuse dilatation sometimes causes difficulty of swallowing without general disturbance. In the majority of cases, however, the patients suffer for years from difficulty in swallowing, repeated vomiting, or regurgitation of food immediately after eating or several hours later. (Mackenzie.) Occasionally there is rumination. At the same time there are increased secretion of saliva and a chronic catarrh; food being retained for a long time in the œsophagus undergoes decomposition, which may lead to fetor. Occasionally there is a sense of severe pressure in the thorax which disappears only after vomiting.

More than 70 cases of idiopathic ectasis have been published, the majority of which were recognized only at autopsy. The clinical diagnosis is rarely made with positiveness. The usual examination with bougies may demonstrate the existence of dilatation, as the bougie is capable of undergoing wider excursions than under normal conditions. Not infrequently it is impossible to advance the bougies as far as the stomach, so that stricture (cicatricial or carcinomatous) or diverticulum might be suspected. The condition of the regurgitated food would lead to the conclusion that it had not come from the stomach (absence of gastric juice, excess of lactic acid, the food being otherwise unchanged). The amount of the regurgitated food (occasionally a quart, Vervière) might lead to the conclusion that there was a diverticulum, for the reason that under ordinary conditions the capacity of the œsophagus is about 100–150 c.c. (Rumpel.)

On performing œsophagoscopy the tube glides down easily; the tip is capable of greater excursion than ordinarily. The folds of mucous membrane bulge more into the lumen of the tube, there are longitudinal folds as well as distinct transverse ruffling of the wall. (v. Hacker.)

Rumpel has suggested the following method for the differential diagnosis between diffuse dilatation and diverticulum of the œsophagus. If possible, a tube is passed into the stomach and a second tube into the dilatation. The stomach-tube has lateral openings.

If there is dilatation, fluid, preferably colored, poured into the tube in the diverticulum will return through the tube in the stomach. If, however, a diverticulum is present, fluid will return through the tube only in the diverticulum.

Exposure to the *x*-rays may show a picture of the dilatation if the œsophagus is filled with a 5 per cent. mixture of bismuth subnitrate. (Rumpel.)

Treatment.—There is no satisfactory treatment for diffuse dilatation. If there is spasm of the cardia of nervous origin, an attempt may be made to apply electric currents to the lower portion of the œsophagus in order to produce contraction of the longitudinal fibres, and thus dilatation of the cardia. If the cardia is permeable for bougies, Symond's retention canula might be inserted, although the use of the latter has its disadvantages. Methodical irrigations may improve this condition, but will not cure it. (Fleiner.)

Feeding with the stomach-tube may improve the general condition and bring about an increase in weight (Rumpel), but as a rule it must be continued for life. Gastrostomy is probably the only method that can produce a cure. At present this is a safe operation which will make it possible to feed the patient; and where there is stenosis of the cardia, permit of dilatation of the latter.

DIVERTICULA OF THE ŒSOPHAGUS.

A diverticulum of the œsophagus is a dilatation limited to the wall of the œsophagus and having the shape of a blind pouch and varying in size. The important feature in a true diverticulum is the mucous membrane lining the sac. If no mucous membrane is present, pseudo-diverticulum, or, in analogy to aneurism, a spurious diverticulum (Bychowski) may be spoken of. Corresponding to Zucker's classification, surgeons distinguish "traction" and "pressure" diverticula, according to whether traction from without or pressure from within causes the dilatation. Pressure diverticula are divided into Zucker's pharyngo-œsophageal, "Grenzdivertikel," boundary diverticula (Rosenthal) and deep or œsophageal diverticula.

Zucker's Pressure Diverticula.—These diverticula possess practical significance, although they do not occur frequently (93 cases, Starch), owing to their situation and the accompanying manifestations. They are more frequent in males (about 76 per cent.), and are usually observed in advanced age (about forty-five years); that is to say, severe manifestations do not set in till that time. Sacculations observed in children were probably not cases of typical diverticula. They are constantly found in the cervical portion of the œsophagus—*i. e.*, the entrance of the diverticulum is situated exactly at the level of transition from the pharynx into the œsophagus, usually in the posterior wall, and generally a little to the left, but occasionally in the middle line, sometimes to the right, but always opposite the cricoid cartilage. If the diverticulum increases in size, it will occupy a posi-

PLATE I.

Cardiospasm, with Secondary Dilatation of the Thoracic Portion of the Œsophagus. At Upper End of Dilatation a Carcinoma, with Perforation into Trachea.

at least under guidance of the finger, or by having the lumen marked by a string passed through it and in such a way as to prevent perforation of the wall of the œsophagus.

The methods employed are: internal œsophagotomy, external œsophagotomy, combined œsophagotomy, excision of the stricture, and gastrotomy or gastrostomy.

Internal Œsophagotomy.—The original method of incising from above downward with instruments constructed like urethrotomes has been abandoned, owing to the danger of causing injury of important neighboring organs, entering a false passage, or dividing the entire thickness of the wall, particularly near the entrance of the stricture. Instruments were devised later which divide the stricture after the latter has been passed and while the instrument is being withdrawn through the constricted portion. Several small incisions, in different directions, are preferable to one single deep incision.

According to the anatomical relations of cicatricial strictures, internal œsophagotomy ought to accomplish more in superficial strictures, as, for example, annular strictures. If œsophagoscopic examination shows the presence of such a stricture, the author would deem it safer to make a number of small incisions with a long, narrow knife or galvanocautery, guided by inspection through the œsophagoscope.

While in other countries this operation has even recently been frequently performed (Demons, Bottini, and others), only a few cases have been reported from Germany (Bergmann, Kölliker). German and Austrian surgeons are generally opposed to this operation, and maintain that although it may have produced good results in a number of cases, it is an operation which cannot be controlled, and which is therefore uncertain and not in accord with modern surgical principles. Besides the danger of hemorrhage, which was severe in a number of cases, and the possibility of cutting through the wall of the œsophagus, it is not a safe plan, according to König, to make a wound on the inner surface of an organ from which phlegmonous processes are so liable to spread.

External Œsophagotomy and Œsophagostomy.—Opening the œsophagus in the neck is applicable, in the first place, in cases of stricture of the cervical portion; but this operation may be also considered in cases of stricture situated lower down, in order to provide easier access to the latter. In cases of stricture of the cervical portion the operation is performed (1) preliminary to excision of the stricture. The latter operation is rarely indicated either in carcinoma or cicatricial stricture. (2) It is employed also in dividing strictures. The latter operation is usually an external one, but may be combined with an internal incision. (3) Finally, the operation is employed for the purpose of establishing a fistula below the stricture in order to feed the patient (œsophagostomy) or for the purpose of dilating the stricture through the fistula. The fistula may be established independently, or after external excision or division of the stricture.

In cases of stricture located below the superior aperture of the

thorax, which in adults is situated more than 20 cm. from the teeth, the above operation (external œsophagotomy) is employed in establishing a temporary œsophageal fistula (1) either for the purpose of dilating a stricture situated lower down, or (2) for the purpose of performing so-called combined œsophagotomy. At present the operation is more frequently performed after complete gastrostomy, where it is desired to carry out more readily dilatation of the stricture.

The technic of external œsophagotomy in case of stricture is the same as in case of foreign bodies. Whenever possible the œsophagus is opened over a bougie passed through the mouth. The latter should be as large as possible (stomach-tube, flexible woven or metal catheter), therefore above the stricture as a rule. The operation is more difficult when the stricture is situated high up and the œsophagus must be opened below the stricture, as under these conditions if the stricture is impermeable, it is impossible to use the bougie as a guide, and it will be necessary to depend upon the anatomical relations, the longitudinal direction of the fibres in a smooth round cord, and to incise the latter free-hand between forceps, with which the muscular coat should first be grasped, and then the mucosa. Frequently it is impossible to recognize the longitudinal and transverse muscular layers on account of cicatricial alteration.

In external division of the stricture the latter is cut longitudinally, similarly to urethrotomy, so that when union takes place the wound is stretched transversely and the constriction is removed. Whether located above or below the stricture, the latter should be divided through the incision in the œsophagus, guided by inspection and after having previously ascertained the path through the stricture by passing a bougie. The question of operation will be considered more frequently in cases of short stricture, particularly superficial, valve-like, crescentic or annular stricture of the cervical portion, than in cases of more extensive, callous strictures. It is not always possible, however, to make an exact diagnosis by examining through the mouth with bougies. Where the stricture is annular and short, and provided the œsophagus has not become adherent to the neighboring structures as a result of cicatrization, it might be possible to suture the longitudinal incision transversely through the wall of the œsophagus.

Experience has shown that external division of strictures is principally adapted to valve-like and sacculated strictures of the cervical portion. v. Bergmann and Billroth each successfully operated in such a case. The permanent result was confirmed in the latter case after two years. In both cases the œsophagus was not sutured. After external œsophagotomy Willy-Meyer successfully performed internal division upon a superficial semicircular stricture situated exactly opposite the opening from above downward, and sutured the wound transversely.

When at the time of operation it is seen that the constriction in the cervical portion is longer than was expected, or that the lumen

cannot be found, as happened to Albert, after the œsophagus had been divided transversely, it is best to perform gastrostomy immediately. In the first case combined œsophagotomy might have been attempted, provided it were possible to open the œsophagus.

As after external œsophagotomy for stricture the wound in the œsophagus is not sutured, but purposely allowed to remain open for a time, the operation may under such circumstances, as well as after external division of the strictures, be employed to establish a temporary œsophageal fistula. For this purpose the wound in the œsophagus is allowed to remain open and a tube passed through it toward or into the stomach. The edges of the œsophageal wound may also be drawn toward the skin with several sutures without being actually united to it. Besides being employed in external œsophagotomy, temporary œsophageal fistula will aid in transversely closing the wound. The operation of temporary œsophageal fistula has also been employed in strictures of the cervical portion which were difficult to dilate, being applied below the stricture for supplying nourishment and for subsequently carrying out retrograde dilatation. In most cases, however, it has been performed for the purpose of dilating strictures situated lower down, beneath the sternal notch; occasionally also for the purpose of performing combined œsophagotomy. The dilatation of stricture situated below the œsophageal fistula, first carried out by Billroth in a series of cases, has recently been recommended by Graser on the strength of his results obtained in Heinecke's clinic.

In general the results obtained by œsophagotomy or œsophagostomy in cases of stricture are not satisfactory. In v. Bergmann's clinic from 1883 to 1893, of 9 cases operated on, 4 died (55.5 per cent. mortality, Pickenbach).

Compared with the favorable results of œsophagotomy in cases of foreign bodies, it is true that dilatation performed after the operation occasionally exerts an unfavorable influence on the course of ulcerative and inflammatory processes. Even in favorable cases the results can only be maintained by continued dilatation. Forcible dilatation is particularly dangerous in cases in which the stricture extends so high up that the œsophagotomy-wound involves the stricture. At this site of transition deep tears of the œsophagus may occur, into which bougies may find their way when employed for purpose of dilatation. The operation also produces a wound in close proximity to the large vessels, which may easily become infected, and as a result of mechanical injury hemorrhage is very liable to occur.

On account of these dangers external œsophagotomy and temporary œsophagostomy are seldom performed primarily in the treatment of intrathoracic strictures. More frequently they are employed secondarily, after establishment of a gastric fistula, where it is not possible to pass bougies from the mouth to the gastric fistula or in the reverse direction.

A permanent œsophageal fistula (actual œsophagostomy) is rarely

established. It might be considered in marked obstruction situated high up, where there is little or no hope of its removal. The obstruction might be caused by carcinoma of the œsophagus or by compression of the œsophagus from without (malignant new growths, struma). But even in these cases gastrostomy would be preferable, as the gastric fistula is less annoying to the patient and can more readily be concealed.

Combined Œsophagotomy.—Combined œsophagotomy was first performed by Gussenbauer in the year 1880, and is a combination of external and internal œsophagotomy. The former is the first step, which must be performed in order that the latter can be more safely and accurately carried out. After opening the œsophagus in the neck —that is, above the constriction—a small olivary bougie is passed into the latter through the wound, and over the olivary bougie is passed a small hollow bougie. Along the latter a fine herniotomy knife is passed and small incisions made in various directions; after this a tube (elastic catheter, etc.) is immediately passed and allowed to remain within the stricture for several days. As soon as possible bougies are passed through the mouth. In this operation it is a good plan to pass two strong silk ligatures through the edges of the wound in order to draw the œsophagus upward and render it tense, as was done by Billroth in passing bougies through strictures situated beneath the cutaneous wound. By this method Gussenbauer was able to enter the canal in spite of extensive stricture. It has been demonstrated that it is possible to perform internal division of strictures situated at the level of the bifurcation in children, and to divide strictures situated just above the cardia.

Gussenbauer's method has not been extensively employed. The operation produces a wound on the inner surface of the œsophagus, with the danger of infection of the latter and subsequent phlegmonous processes. The method can only be employed where it is possible to reach the interior of the œsophagus or the stricture, and to pass a fine bougie into the latter through the wound in the neck. It is most applicable to division of short, annular strictures situated high up (in adults not higher than the bifurcation). The operation might also be considered when, on making the external œsophagotomy incision, it is seen that the stricture extends downward into the thorax, or that in the latter region there is a second stricture which cannot be immediately dilated through the wound. This method does not insure against recurrence.

In most cases of severe stricture, even those situated in the cervical portion, and at best in those situated below the sternal notch, the establishment of a temporary gastric fistula is the most practical method. If dilatation through the mouth and gastric fistula is not successful, it should be attempted through an œsophageal fistula. In case of recurrence or of failure of dilatation internal division of the stricture through the œsophageal fistula, according to Gussenbauer's method, might be employed. After gastrostomy has been performed, the prin-

cipal danger of the operation could be prevented by laying iodoform gauze in the wounded portion of the œsophagus for several days, inserting the gauze by means of a string passed from the œsophageal fistula to the gastric fistula, or in the reverse manner.

Lange employed an artificial gastric fistula in order to pass a knife into the stricture from below upward in performing internal incision. Strictures have also been divided by means of a silk string passed from the opening in the stomach to the mouth, or from the stomach to the œsophageal fistula, by drawing the string back and forth (Abbe's method).

Excision of Stricture of the Œsophagus.—The transition from œsophagotomy to simple incision of superficial crescentic or valvular folds of mucous membrane produced by cicatrization and the plastic suturing of the wound (Willy-Meyer) to actual resection of the œsophagus is represented by Kendal Frank's method, successfully employed in one case. Through an œsophagotomy-wound a constricted band of healthy mucous membrane, one and a half inches broad and probably of congenital origin, was excised and the edges of the wound sutured. This operation might be employed in a cicatricial ring involving only the mucous membrane.

Experience has shown that complete circular resection of the constricted portion of the œsophagus is to be considered in severe forms of circular, callous strictures, also in short tubular strictures limited to the cervical portion of the œsophagus. The ends of the œsophagus should be brought together and sutured, or, when this is impossible, the defect should be closed by means of a plastic operation. Preliminary gastrostomy would lessen the dangers of the operation (peri-œsophagitis, mediastinitis, sepsis). The question of resection would enter principally into cases of carcinoma, and will be discussed more fully on page 118.

Cases of cicatricial stricture to which this operation is adapted are rather rare, as after injuries caused by caustics even strictures involving the deeper tissues can still be treated by dilatation. Besides syphilitic and tuberculous strictures, to which Heinecke drew attention, those following diphtheria might offer indications. (The latter form of stricture is more frequently situated at the level of the bifurcation.) H. Braun recommends resection where there are folds or pockets of mucous membrane in addition to the stricture, and where the former are the principal cause of difficulty in swallowing.

Resection of the œsophagus has been performed 4 times for annular cicatricial stricture of the upper portion of the œsophagus (the stricture being from 1 to 2 cm. in extent), 3 times with complete success, first in 1891 by H. Braun, later by Sandelin (1899); in both the cases the stricture was caused by caustics; also by Escher (1900) for syphilitic stricture, once (1898) by Krogius, with death from sepsis (stricture caused by caustic)—mortality, 25 per cent.

Braun left the œsophagotomy-wound open over the site of suture (a feeding-tube was passed through the latter). In Escher's case there

remained a small opening at the edge of the preliminary œsophagostomy. This case was complicated by a slight degree of retro-œsophageal suppuration. Of 2 cases in which the œsophagus was completely closed by a circular suture (Krogius, Sandelin), there was primary union except for a small temporary fistula. In the cases of Sandelin and Escher the patients were fed by rectum during the first period. Krogius passed a retention tube through the nose.

In cases of pure superficial, valve-like stricture of the cervical portion it seems simpler to divide the folds of mucous membrane, either by the aid of œsophagoscopy and galvanocautery or after external œsophagotomy, or to resect the folds of mucous membrane (even where the latter are circular), and the scars, with subsequent suture of the wound (Kendal-Frank) as far as is possible through the external œsophagotomy-wound. This latter method promises a better result than complete resection of portions of the œsophagus.

In short tubular strictures, limited to the cervical portion, which are not dilatable by simply dividing the constricted portion, the defect in the anterior half of the latter might be replaced by the formation of a long-lipped fistula, and by subsequently inverting the outer skin (external œsophagoplasty). The author proposed this operation in 1889. It must be admitted, however, that the period of recovery is considerably longer. The operation may be performed primarily or after external division of the stricture has failed. The lipped fistula can then be left open until other constrictions situated lower down have been dilated. During this time the patient can swallow food through the mouth if the opening in the œsophagus be closed anteriorly by a plate, or a rubber tube attached to the latter inserted into the upper and lower portion.

Gastrotomy and Gastrostomy.—Both methods of operation are employed at present for the purpose of dilating strictures of the œsophagus through the stomach. Their introduction was only rendered possible by the modern method of treating wounds, through which the dangers of opening the abdominal cavity and the stomach have been so much lessened.

Gastrotomy is certainly the more dangerous method, and is not applicable to cases with extensive scar formation that require protracted dilatation through the opening of the stomach, unless thereby the stricture were made passable for a small-size bougie, and at the end of the operation a gastric fistula were established for the purpose of subsequent dilatation. A gastric fistula must also be established in those cases in which a bougie cannot be passed through the stricture from the incision in the stomach. (Moulin.)

The stomach is opened in the usual way (see under Gastrotomy). Further steps are as follows: The edges of the incision are retracted by means of clamps or loops of silk, and according to the size of the incision the index finger or two fingers are inserted into the incision in such a way as to occlude the wound. The anterior wall of the stomach being inverted, and the whole hand being passed into the peri-

toneal cavity, the cardia is searched for with the index finger in order to reach the lower end of the stricture if possible. A safer plan would be to draw the stomach and transverse colon outside the peritoneal cavity, as in posterior retrocolic gastro-enterostomy, to pack around the former, and after removing the stomach contents to enlarge the incision sufficiently to pass the whole hand into the cavity of the stomach in order that inversion of the anterior wall of the stomach may be avoided.

Guided by the finger, an attempt should be made to pass a sound through the stricture from the stomach. If this is not successful, the stricture should be incised from the stomach by passing instruments (forceps, dilator, blunt urethrotome, etc.). If the stricture has been dilated sufficiently to pass a bougie from the mouth, a piece of iodoform gauze (Kendal-Frank) or a large drainage-tube is drawn into the stricture by means of a string passed from the mouth to the stomach, the wound in the stomach is carefully closed with sutures, and the abdominal incision closed over the latter. The object of this method is to reach the cardia more easily, which in adults is situated about 20 cm. from the abdominal incision.

If it is not possible to accomplish dilatation at the time gastrotomy is performed (Moulin), or if protracted dilatation through the stomach is desirable, the wound in the stomach is carefully closed by a double row of silk sutures, leaving an opening to form the fistula, surrounding which the stomach is sutured to the parietal peritoneum and fascia, the remaining portions of the latter being sutured separately. The abdominal incision is closed except at the site of the fistula. A drainage-tube is passed into the latter from without. A string is drawn out through the tube, having been attached to the œsophageal tube (drain) inserted into the stricture from the mouth. (Körte.) In most cases in which permanent results are hoped for, it will be desirable to establish a gastric fistula after gastrotomy, as after complete closure of the gastric incision and the abdominal cavity, as in Loreta's method; subsequent dilatation can only be carried out from the mouth.

In the author's opinion it is advisable to carry out gastrotomy by a longitudinal incision through the middle of the left rectus muscle (v. Hacker) in view of the fact that it is generally better to establish a gastric fistula at the close of the operation. If this incision is made sufficiently long, enough room will be provided, and after dilatation has been completed, or after the stricture has been rendered passable and a drainage-tube has been inserted into the latter, the string attached to the tube can be led out through the fistula after the rest of the incision in the stomach has been carefully sutured. It would be possible also to close entirely the incision in the stomach, and utilize some other portion of the organ for the establishment of a fistula between the recti muscles. If more space is required for manipulation within the abdominal cavity and within the stomach, and if for this reason Fenger's incision has been chosen, it is more difficult to close the gastric fistula. If "dilatation" is to be carried out subsequently, it is ad-

visable to combine Kader's or Lucke's method of gastrostomy, with the formation of a sphincter from the rectus muscle.

For the purpose of treating stricture of the œsophagus, particularly strictures situated in the lower thoracic portion, gastrostomy is the operation most frequently employed, and properly so. In fact, it may be called the normal method in all those cases in which operative interference is necessary because the stricture is not passable from above.

In these cases the treatment requires the establishment of a temporary fistula, with subsequent, usually retrograde, dilatation with bougies, the latter being generally followed by dilatation. The operation is urgently indicated in cases with marked inanition. The operation is usually performed in one stage, and not in two stages as formerly. Dilatation is carried out by slower and safer methods, and the principal danger of gastrotomy, infection of the abdominal cavity by the entrance of stomach contents, is prevented by commencing the treatment of the stricture only after the stomach has been securely united to the abdominal wall.

The annoyance of a large gastric fistula, and the interference with nutrition caused by the latter are so serious that at present gastric fistulæ, intended for the treatment of strictures, are made very small, as in cases of carcinoma of the œsophagus. This method has only come to be employed within recent times. At present surgeons are able to suture firmly the stomach to the abdominal wall wherever it can be drawn into the abdominal incision without force in such a way that there is no danger of the former being torn away, and without making it necessary to have the stomach completely empty. At the same time methods have been sought for which would, in the first place, permit of exact closure of the fistula, also methods by which the fistula was formed in such a way that the latter would close spontaneously as soon as it was not maintained artificially, or could be closed by some minor operation (Paquelin cautery, or freshening the edges without opening the abdominal cavity). Experience has shown that in many cases after establishment of gastric fistula impermeable strictures become passable spontaneously, or are rendered dilatable from the mouth by simple rest. This expectant treatment is desirable in order to stimulate exhausted patients by proper nourishment and to give necessary rest for the œsophagus, which has been irritated and become swollen in the region of the stricture as a result of attempts to pass bougies.

Frequently it is possible after gastrostomy (at times four to six weeks, sometimes only after months) to pass a fine bougie or gut string into the stomach and to draw it out through the fistula. Occasionally this can also be done in the opposite direction from the stomach. As soon as this has been accomplished, subsequent dilatation of the stricture is assured by the method of dilatation. (v. Hacker.) The most effective method, introduced by the author in 1885, is that of leading drainage-tubes of increasing size by means of a string attached to a bougie. The drains are inserted into the stricture under some tension, and,

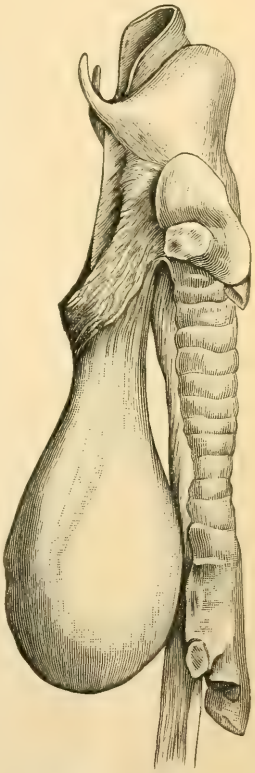
tion at the side of the œsophagus, and hang down in this situation in the shape of a pear-shaped sac. It may attain the length of 13 cm. or more. Some have even extended into the thoracic cavity (5 cm. or more, Pfister). The mouth of the diverticulum may be as large as the body of the sac, but as a rule it is narrower, there being at the same time a short neck or pedicle.

In one of König's cases the diverticulum was placed to the left of the vertebral column, extending forward in front of and past the œsophagus and trachea, toward the right, reaching as far as the vertebral column on that side.

In a number of cases diverticula have been observed to rise higher up, from the lateral wall of the pharynx. Zucker has separated these formations from true diverticula of the œsophagus. They are rare and bear no relation to the œsophagus.

Diverticula vary in size from that of a cherry to that of a child's head. As far as their anatomical structure is concerned, they generally possess a rather thick wall, and, as has been mentioned, are completely lined with mucous membrane, which is usually covered with squamous epithelium, although cylindrical epithelium is occasionally found. (König.) Muscular fibres are not always distributed throughout the whole sac, but frequently only about the œsophageal opening. A number of cases have been described, however, in which muscle-fibres were found in all portions. (Schwarzenbach, König, Kraske, (Bartelt), Billroth, v. Bergmann.) The mucous membrane lining the sac very frequently shows papillary hypertrophy; occasionally ulcerations are found, which are probably caused by retention of food in the sac (chronic œsophagitis).

FIG. 30.



Pulsation diverticula of the œsophagus. (König.)

The origin of diverticula has not been clearly determined. It has been assumed that pressure from within, caused by regurgitation of food, or in individual instances severe retching or habitual vomiting (Kocher), may cause the œsophageal wall to bulge out at a certain site, and that continued exercise of pressure causes the formation of a sacculation. This can be true only provided this particular site possesses less power of resistance than the rest of the œsophagus. In 1883 Laimer described a triangular area at the posterior wall of the extreme upper portion of the œsophagus, where for about 3 cm. the external longitudinal muscular layer is wanting. This corresponds exactly to the entrance of these diverticula. That

pressure in the œsophagus may occasionally be considerable is shown by the circumstance that occasionally it causes existing diverticula to increase in size and to extend further down.

Traumatism has frequently been suggested as an etiological factor—impaction of a cherry-stone (Ludlow), of a bone (Kühne), falling from a horse (Frieberg). It has been pointed out that through struma or ossification of the laryngeal cartilages the passage of food is interfered with, and that consequently a dilatation of the opposite wall is produced. Circumscribed paralysis of muscles has also been considered as a cause. Others, again, have rejected these views, and have referred the origin of diverticula to disturbance in development. (König, v. Bergmann, Albrecht, Mixter.) Albrecht claimed that he found analogous formations in animals.

Probably the tendency is congenital (weakness of the triangular space). Dilatation through pressure depends upon various factors, some of which have been described.

The manifestations which characterize diverticula take place only when the later have attained a certain size, and have resulted in the formation of a sac lying at the side of the œsophagus.

Patients with well-developed diverticula frequently refer the earliest manifestations ten, twenty, or thirty years previously. The latter vary in character. Occasionally in the beginning there is only a mucous expectoration or a sensation of pressure while eating solid food. (Billroth.) In other cases eructations after eating occur, and vomiting without much disturbance on the part of the patient, of small quantities of food recently swallowed, particularly dry and solid particles of food. Occasionally this phenomenon is accompanied by convulsions which cease only after eructation, or vomiting. Such patients are not infrequently treated a long time for stomach disorder.

The statement has been made that fluids are more liable to enter a diverticulum, while semifluid or solid food can more readily be swallowed; in some cases, however, the opposite is seen. (Butlin.)

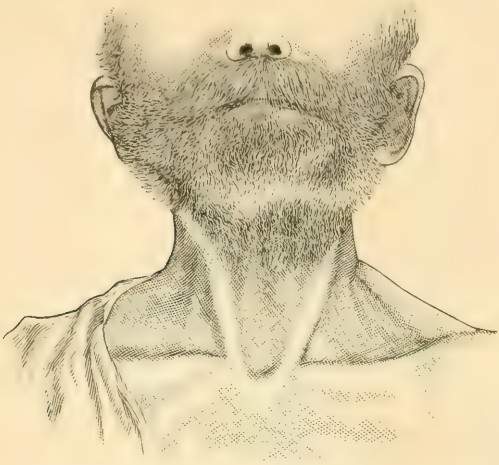
As long as a diverticulum is small, the first portions of food may always be caught, whereupon the rest of the food is swallowed without difficulty as soon as the diverticulum has become filled. As the diverticulum increases it may compress the œsophagus and thus cause severe disturbance. Sometimes it is still possible to swallow small amounts of food before the diverticulum becomes filled. In most cases, however, even this soon becomes impossible. The filled-up diverticulum causes a feeling of pressure in the neck and may produce congestion through compression of the neighboring vessels. (v. Hacker.) Occasionally a distinct swelling of the neck can be seen and felt, situated usually upon the left side.

If the diverticulum has become filled and the œsophagus is compressed, all the food entering the latter is immediately regurgitated. The patients can usually force food out of the diverticulum into the mouth by producing pressure on the respective side.

Sometimes evacuation of the diverticulum takes place involunta-

rily through contraction of the cervical muscles, particularly if there are numerous adhesions with the latter. If food is not expelled from

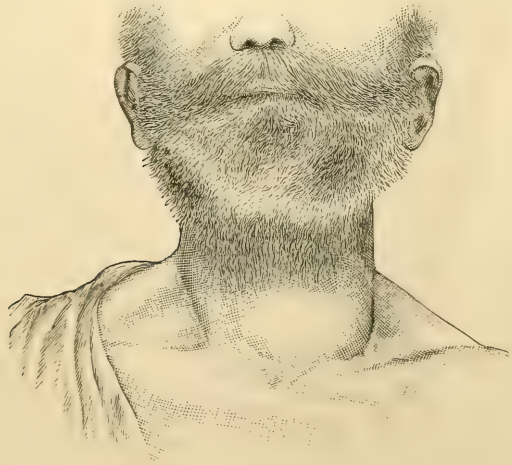
FIG. 31.



Pulsation diverticulum, empty. (Observed in Billroth's clinic.)

the mouth, but is swallowed, rumination takes place. After evacuation occasionally a small quantity of food may enter the œsophagus and the stomach. The majority of patients are obliged to hold the

FIG. 32



Pulsation diverticulum, filled. (Observed in Billroth's clinic.)

head in a certain position; other patients learn that by exercising a certain pressure on the neck it is possible to have food enter the œsophagus. But even so they frequently require hours for their meal.

(König.) As in most cases it is impossible to force all food out of the diverticulum by pressure on the neck, there is decomposition of stagnant food, causing fetor which frequently becomes intolerable. Occasionally patients are obliged to wash out the diverticulum by diluting the remains of food with fluid, and then forcing this out till the odor disappears. If decomposed food reaches the stomach, there may be other symptoms in addition to those mentioned, which are apparently referable only to the stomach. There may be actual irritation of the stomach and the entire digestive tract (eructation, true vomiting, flatulence, colic, etc.).

The occurrence of a swelling in the neck, which is by no means a constant symptom (30 per cent. of all cases), usually attracts the attention of the patient. This swelling is frequently similar in appearance to goitre, and may after consumption of large quantities of fluids appear on both sides (Pfister) and thus render the similarity to struma still more striking. In case of smaller diverticula existing goitre may conceal the swelling.

The diagnosis is generally easy if the symptoms mentioned are carefully noted. The history of gradual development of the disturbances and regurgitation of unaltered food should arouse suspicion that a diverticulum is present. If a tumor in the neck develops during eating and can be emptied by pressure, it is still more probable that there is a diverticulum.

Examination with bougies offers the best means of arriving at a conclusion. If a bougie is passed, it will generally be arrested at a point not far distant from the cricoid cartilage, on the average 20–23 cm. from the teeth. The bougie may be felt from without through the neck. (Butlin.) In order to distinguish from a stenosis it is important that the tip of the bougie be freely movable within the sac, particularly toward the sides, as this would point to dilatation.

A series of observations have shown that closure of the œsophagus is caused by the fact that the crescentic border forming the entrance becomes applied to the anterior wall of the œsophagus like a valve (König, Mixter) in such a way that the diverticulum, hanging down, forms the actual prolongation of the œsophagus. The lumen of the œsophagus is apparently an opening in the anterior wall of the diverticulum. These anatomical relations explain why, particularly if the diverticulum is empty, a bougie can be passed into the stomach without meeting with obstruction, which would not be the case if stricture of any kind were present.

v. Bergmann considers this phenomenon of a bougie being arrested at one time and passing easily at another, a positive sign of diverticulum of the œsophagus. Occasionally when a bougie has been passed into the diverticulum a second bougie may at the same time be passed into the stomach. This would be impossible if there was stenosis. In carcinoma, in which it may happen that a bougie can be passed at one moment and not at another, the remaining signs (situation, gland-

ular enlargement, necrosis, examination with œsophagoscope) will render the diagnosis positive.

If a bougie can be successfully passed into the œsophagus, it must be withdrawn the entire length of the diverticulum before it can be again advanced. In the presence of stenosis or dilatation above the stenosis, which is rare, this would not be the case.

Regarding the value of œsophagoscopy in cases of diverticulum there are only a few observations (v. Hacker, Rosenheim, v. Mikulicz, Hanszel, each 1 case; Killian, 3 cases).

In v. Hacker's case the diverticulum was apparently a folded sac of mucous membrane, the walls of which were covered with a mucous secretion. Owing to the restlessness of the patient it was impossible te obtain a distinct view of its entrance into the œsophagus. At the same time it was possible to make out a firm fold of mucous membrane, concave above, and in front of this the signs of a lumen. This difficulty is explained by the fact that the diverticulum usually arises at the level of the cricoid cartilage at a point where it is difficult to obtain a clear view with the œsophagoscope.

Œsophagoscopy would be useful in this condition in order to determine the diameter of the neck or pedicle of the diverticulum, which is important from the point of view of diagnosis; also to locate the entrance into the œsophagus, and thus render it possible to institute regular dilatation. If the patient suddenly swallows, the lumen of the œsophagus will suddenly open. (Killian.) This moment should be chosen for the passage of the bougie.

Percussion may show dulness over the chest where the diverticulum extends low down in the thorax (32 cm. from the teeth, Neukirch, Pfister), over the upper portion of the thorax anteriorly or on the right side from the third to the fifth dorsal vertebræ behind (Neukirch). This dulness disappears on emptying the diverticulum. (Kocher, Neukirch.) There may be a zone of tympanitic resonance from the clavicle upward in the region of the sternomastoid muscle. (Pfister.) *X*-rays may also be employed as an aid to diagnosis. (Blum.)

Treatment consists of non-operative or operative interference. Dilatation has been employed in case of diverticulum, as in all cases of obstruction of the œsophagus, but there is only one instance in literature in which a cure was effected and confirmed nineteen years later.

Birkhan took a rather large tapering gutta-percha bougie with a blunt, rounded tip and curved similarly to a Mercier catheter; with this instrument he dilated a patient in whom König had found a diverticulum reaching to the sternum. When the patient died of pneumonia it was found that the diverticulum was the size of a hazelnut. Schede applied the faradic current to the entrance of the diverticulum; the latter contracted. He then passed into the œsophagus a copper wire armed with a round tip and curved like Birkhan's bougie; over this he drew stomach-tubes of increasing size. Through the tubes semifluid food was introduced. Later it was no longer necessary to employ the faradic current, it being sufficient simply to bend the

head backward. Neukirch improved on this by having the patient lie horizontally and on the right side while eating. In this way the walls of the diverticulum, situated on the right side, were applied to each other, the entrance of the œsophagus became more free, and it was possible to get food into the stomach.

Such results are, however, exceptional, and for that reason operative methods were considered. Gastrostomy must be mentioned as a palliative method of treatment. This was first recommended by Schönborn in 1877. In every case in which it was employed the patient died of pneumonia (Chavasse, Häckermann); only one lived for three years (Whitehead). König recommended gastrostomy as a preliminary operation to extirpation of the diverticulum in order to avoid feeding by the mouth till the wound in the œsophagus had healed. In the author's opinion, however, preliminary gastrostomy is indicated where the patient is so exhausted that he will in all probability not survive the more severe operation of extirpation, particularly for the reason that during the first few days after extirpation not much food can be given, while gastrostomy performed in one stage does not occasion difficulty or danger.

Extirpation of the diverticulum, proposed by Kluge at the beginning of the nineteenth century, must to-day be considered the best method for permanent cure of this condition. As in its removal the wound is liable to be infected by the contents of the sac, it is advisable to wash out the sac before operation, and not to fill it by giving the patient a small meal. (König.) Placing compresses beneath the sac will protect the wound (Billroth), but this precaution will not prevent food being aspirated during anæsthesia. The latter occurrence may lead to death from pneumonia and gangrene of the lungs. (Kraske.)

Incision is made along the inner border of the sternomastoid muscle, on the right or left side, according to the situation of the diverticulum, and is carried from the level of the hyoid bone as far as the clavicle, so that the level of the cricoid cartilage is placed about at the middle of the incision (Kocher made his incision from the lateral border of the thyroid cartilage vertically downward). The sternomastoid muscle is retracted outward. It will not be necessary to divide partially or completely the muscle as suggested by Kocher, unless a coexisting struma is in the way. Billroth was able to draw the sac up from behind the clavicle without dividing the muscle. The thyroid gland is forced inward. In doing so, it is frequently necessary to ligate the inferior thyroid artery, after having divided the deep fascia of the neck along the external border of the inferior hyoid muscle (sternohyoid). It occasionally is necessary to ligate the superior thyroid artery.

v. Bruns found it necessary to remove one-half of the thyroid gland. The omohyoid muscle can be spared and retracted outward or it may be divided.

The œsophagus is now searched for. The edge of the thyroid cartilage may be retracted from the vertebral column with a sharp retractor. (v. Bergmann.) As it is frequently difficult to distinguish the diver-

ticulum from the longitudinal fibres of the œsophagus, it is advisable to pass a bougie from the mouth into the diverticulum and to look for the inferior convex border.

Enucleation is generally easy, like that of a hernial sac, provided there are no firm adhesions with the surrounding tissues; under such circumstances the sac may be torn. Where this occurs, compresses should be used to protect the wound from being infected by the contents of the sac. As soon as the diverticulum has been freed as far as its neck it may be divided step by step from below, and the wall successively sutured (König), or a temporary ligature may be thrown around the neck of the sac and the adventitia and muscular coats divided, a double ligature then tied about the mucosa and the latter divided between the ligatures with a thermocautery. (Kocher.) The adventitia and muscular coats are now freed from the ligature. Although both of Kocher's cases healed by primary intention, it is possible that in dividing with a thermocautery the slough might interfere with primary union.

The wall of the œsophagus should be carefully sutured. The best method is that of intestinal suture, in separate layers (mucosa, muscular coat, and adventitia). König used catgut, others used silk; the choice of material is of little importance. Nicoladoni has recommended inversion of the stump of the diverticulum toward the œsophagus and suturing the adventitia in order to make a tubular valve (Röhrenventil), which would prevent the entrance of food into the wound. Girard recently employed this idea, and inverted the entire thickness of the diverticulum. In the process of inversion he inserted three successive purse-string sutures (in 2 cases). Czerny also employed this method in 1 case. The result was a knot in the œsophagus like a polyp, and after a short time deglutition became normal, the diverticulum undergoing contraction. Girard recommended his method for only small and medium-sized sacs.

It is advisable not to close the wound completely, but to lay a strip of iodoform gauze from the œsophageal suture out through the skin-incision. If the sac occupies the entire region behind the sternum, it is well to drain or pack this region also. (König.) The gauze drains may be removed after a few days, a larger tampon after about two weeks. (König.)

During the after-treatment it is important to decide whether a stomach-tube should be inserted or not. In Billroth's case a tube was left in place for four days. It is certainly true that nourishment can be better provided in this way than by the rectum, but when one considers that the majority of these patients have an ossified cricoid cartilage (this condition has even been considered an etiological factor), it is to be feared that the tube may cause pressure-necrosis at this point, as is so frequently seen in employing a permanent tube after operation for carcinoma of the tongue, and as occurs when drainage-tubes are left in place for the purpose of dilating strictures. In order to avoid this danger, and in order not to expose the suture to the risk of frequent

insertion of a tube, enemata have been employed for the first four days. After this clear fluid and wine can be given by mouth; or if infection of the suture is to be absolutely avoided, sterilized peptone salt solution (Kocher); after ten days egg, consomme, later gruels and scraped meat. Solid particles of food should not be swallowed for some time. (König.) In most cases a small fistula develops six or seven days after operation, through which fluid escapes. Under such circumstances König recommends feeding only with the stomach-tube. These fistulæ frequently require some time to close (five weeks, Billroth; twelve weeks, v. Bergmann), but they usually close spontaneously or after applying a thermocautery.

Extirpation of diverticula has been performed 27 times, with 5 deaths. One patient (Zesa's) died of a subsequently performed gastrostomy; the other cases died of anuria on account of an existing nephritis (cited from Butlin), pneumonia (Krase), erosion of the superior thyroid artery (Niehaus), pneumonia, and sublimate enteritis (v. Burckhardt).

Prognosis.—Compression of the œsophagus by the diverticulum frequently results in inanition, in spite of treatment with bougies, and will result fatally unless death is caused by some intercurrent disease acting on the weakened organism. Of 66 patients regarding whose fate there are reports (Starck), 26 died from the consequences of the diverticulum after great suffering.

Death may also result from the aspiration of vomited food (pulmonary abscess, Classen). Ulcerations in the diverticulum may lead to retropharyngeal and paræsophageal phlegmons. It has also been reported that carcinoma developed from diverticula (Newton-Pitt, Edgren), probably originating in ulcerations.

Deep-seated Diverticula.—Besides pressure diverticula of the entrance to the œsophagus and traction diverticula there are found sacculated dilatations which are to be considered deep-seated diverticula. They are rare, but are mentioned as they may give rise to confusion.

Przewoski found diverticula in the middle and lower portions of the œsophagus in 7 cases. They were the size of a hazelnut; their floor was arched, not funnel-shaped; they had a wide opening, and on their outer surface there was no trace of adhesions. They cannot therefore be considered traction diverticula. Since then a small series of diverticula has been described, situated in the same region, and which had a capacity of 100–500 c.c. (Mintz, Reichmann, Kelling, Bychowski, Reitzenstein.) According to Starch, a similar series of observations are to be found in older literature. There are also congenital diverticula of this same kind. (Vigot.) They are dilatations of the anterior œsophageal wall including the muscular layer. Their apices are inserted into the bifurcation of the trachea and may be due to errors of development. They should not be mistaken for traction diverticula. It is very easy to assume that from such small diverticula (whether congenital or acquired) larger sacs may have de-

veloped, possibly by a sort of pressure from within. A few patients stated that they always ate rapidly, did not properly chew their food, and swallowed large pieces. These diverticula also occur more frequently in males. The majority of the patients were over forty years old when they applied for treatment. The disease may, however, begin early (twelve years, Bychowski) and continue for a number of years before medical aid is sought.

Symptoms.—The symptoms are vomiting or regurgitation of food while eating or soon after. The vomiting occurs without effort, and may occasionally be exerted voluntarily by inspiration during closure of the glottis. After vomiting the patients are able to eat for a while. Occasionally, it is stated that after eating there is a sense of pressure or weight in the region of the sternum. The disturbances slowly increase in intensity, larger quantities of food are vomited, and less food enters the stomach, so that the patients become gradually much emaciated.

The entrance to these diverticula is situated in the middle portion of the œsophagus, about 20 or 30 cm. from the teeth. The bottom of the sac is recognized by the bougie meeting with an insurmountable obstruction at a distance of from 40 to 46 cm.

Diagnosis.—Examination is best conducted by means of a bougie, the tip of which is curved like a Mercier catheter (Kelling), as Birkhan has recommended for pressure diverticulum. With these bougies it is generally easy to pass by the diverticulum, and it is possible also to determine whether sacculation is situated to the right or to the left of the median line. This might be determined as easily by œsophagoscopy. It is easier also to determine the distance of the entrance into the diverticulum from the teeth by œsophagoscopy than by the complicated test-methods usually employed (insertion of double-barrelled tubes, held together with strips of adhesive plaster, and pouring in colored fluids, in order to determine the height of the diverticulum, and other methods). There is no swelling in the neck. The vomited food is almost unchanged, hydrochloric acid is usually absent, while lactic acid is generally present in large quantities ; occasionally there are also flakes of squamous epithelium. (Bychowski.) Upon examination with bougies, in case of diverticulum, the instrument at first meets with an obstruction ; on being withdrawn it can be advanced without meeting resistance, usually only after the contents of the sac have been evacuated (absence of stricture). It will be possible then also to obtain stomach contents (hydrochloric acid, possibly bile). If two tubes can be passed at the same time, one into the diverticulum and the other into the stomach, different colored fluids can be poured into the tubes. They will flow out unmixed.

As an aid to differential diagnosis between diverticulum and diffuse dilatation the tube in the stomach may be provided with lateral openings. If there is dilatation, fluid poured into the tube in the diverticulum (it is better to employ a colored fluid) will flow through the lateral openings into the stomach. If a diverticulum is present,

nothing will flow out of the tube in the stomach, or only what is in excess of the capacity of the diverticulum, while from the tube in the diverticulum all the fluid poured in will be recovered; that is to say, an amount equalling the capacity of the diverticulum. (Rumpel.)

The *x*-ray may also be employed for the purpose of obtaining information as to the situation, form, and size of the diverticulum. If the sac be filled with a bismuth mixture, the diverticulum will give a shadow. If a bougie filled with shot or one provided with a lead guide is passed, the shadow thrown by the latter will give the contour of the sac, and thus afford information as to the seat of the diverticulum.

Treatment.—Irrigations with mild antiseptic solutions will prevent decomposition of food and resulting irritation of the mucous membrane (ulceration). Patients tolerate this form of treatment well and are subjectively improved. As it is usually easy to enter the stomach after emptying the diverticulum, dilatation treatment might promise good results. This is best carried out with the sound devised by Kelling. The patient may be directed to eat while lying down, as suggested by Neukirch.

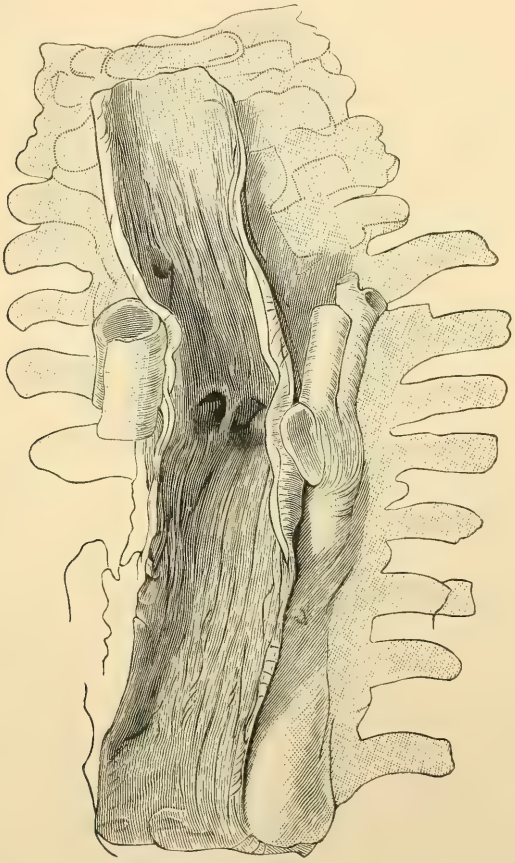
Traction Diverticula.—Traction diverticula are of greater pathological and anatomical than clinical interest, as they usually run their course without producing symptoms, and are only occasionally found at autopsy. They are of a certain significance, however, for the reason that they may have serious consequences. Relatively they occur quite frequently; they are certainly more frequent than pressure diverticula. They are most frequently caused by softening and suppuration of mediastinal and bronchial lymph-glands, particularly in tuberculosis of the latter. These glands are most frequently situated at or below the point where the œsophagus crosses the left bronchus. They undergo contraction after having softened, or not infrequently after having ruptured into a bronchus or into the œsophagus itself. As they are usually adherent to the œsophagus, the anterior wall of the latter is drawn out by cicatricial contraction, resulting in small dilatations of the œsophagus, as first described by Rokitansky.

As a rule only one diverticulum is found, but occasionally there are a number of them (two or three above each other). They are rarely larger than a hazelnut, funnel-shaped, the apex of the funnel being directed upward, forward, or to one side; less frequently it is directed downward. Corresponding to the situation of the above-mentioned glands, they are located in the anterior wall of the œsophagus, near the bifurcation. Traction diverticula do occur which are not located on the anterior wall, but these forms are more rare, and result from mediastinitis or follow caries of the spine. (Fig. 33.) v. Hacker observed traction diverticula following perichondritis and necrosis of the cricoid cartilage; Chiari, after adhesion of the œsophagus with the thyroid gland where the latter had undergone colloid cystic degeneration. Diverticula generally consist of muscular coat and mucosa. Some diverticula are composed only of mucosa. There

is in most cases a complete mucous membrane lining, but at the apex of the funnel there may be cicatricial tissue instead of mucous membrane, which would point to previous perforation of the œsophagus.

Remains of food, particularly harder particles, or pieces of bone, may lead to ulceration and perforation where there is absence of mucous membrane at the apex of the funnel. In this way mediastinitis, gangrene of the lungs, etc., may occur. (Rokitansky, Cöster.) This is a constant source of danger to the patient.

Fig. 33.



Traction diverticulum of the œsophagus from caries of vertebræ.

As a rule traction diverticula run their course without producing symptoms. They produce no difficulty in swallowing. Tiedemann has drawn attention to the fact that in cases in which such diverticula were found at autopsy the patients had complained that granular particles of food like rice were liable to remain caught. Where one meets with this statement it might be possible to make a positive diagnosis by employing the œsophagoscope. Examination with fine

bougies (Zenker) will in all probability be successful only where the funnel is directed downward.

Under extraordinary circumstances such a traction diverticulum may be stretched by the pressure of entering food, usually in such a way as to cause separation of the muscular coat and the production of a hernia consisting only of mucosa. These so-called traction pulsion diverticula (Tiedemann, Ockonomides, Teteus) involve a more serious danger for the patient, as on account of the retention of food for a longer time and increased tension there is greater tendency to perforation. Teteus found that of 88 traction diverticula 6 were secondarily dilated by pressure from within.

There is no satisfactory treatment, even if the diagnosis should be made during the life of the patient. It is limited to prophylactic measures, particularly avoiding rapid eating and drinking, and limiting the patient to a soft or fluid diet. If perforation takes place into the air-passages, feeding with the stomach-tube or gastrostomy is indicated.

NEW GROWTHS OF THE ŒSOPHAGUS.

Cysts, Papillomata, Myomata, Sarcomata of the Œsophagus.—Some of the growths occurring in the œsophagus, such as warts, cysts, papillomata, fibromata, lipomata, and myomata, possess only a pathological-anatomical interest, as these tumors rarely cause disturbance.

Klebs has pointed out the analogy between diseases of the œsophagus and those of the external skin. Thus in the œsophagus are found *warts*, which are generally small and distributed over different portions. It might be readily conceived that the latter could develop into carcinoma analogous to cutaneous warts, but this transition has never been proved. The warts may project into the lumen in the form of tufts, but do not cause characteristic manifestations. They are only occasionally autopsy findings.

Retention-cysts of the mucous glands have also been described. They may attain the size of a cherry or that of a hazelnut (Klebs), and be lined with ciliated epithelium (Zahn). Owing to their small size they usually run their course without producing symptoms. There are some cysts, lined with ciliated epithelium, wedged between the trachea and the œsophagus, which are looked upon as degenerated remains of the communicating canal between the œsophagus and trachea. They may attain sufficient size (3 to 6 cm.) to compress the œsophagus. (Eppinger, Petrow.)

Papillomata may cause difficulty in swallowing, manifested by slow descent of food when swallowed. Examination with bougies may show a slight obstruction; a portion of tissue may be caught in the fenestrum of the bougie, thus making the diagnosis positive. (Reher.)

Fibromata and *lipomata* also occur, originating in the submucosa (Zenker); also myomata originating in the muscular coat. The number of cases of myomata described in literature is small. They occur at different levels of the œsophagus, at any age, do not usually attain great

size, and therefore usually run their course without producing symptoms. In most cases they occurred as solitary or multiple tumors (14, Pichler). Cases of rhabdomyomata have also been described. They are more malignant in character, produce metastases in the lymph-glands, and cause difficulty in swallowing owing to the fact that they grow rapidly and may attain considerable size.

Fig. 34.

Myoma of the œsophagus.

Fig. 35.

Sarcoma of the œsophagus.

Sarcomata of the œsophagus are similar to carcinomata in many respects. They are located preferably at the entrance of the œsophagus and near the bifurcation. As a rule these tumors are not large, but they may present an ulcerated surface 6 cm. in extent. They also produce metastases in the bones (Rolleston), and may be either spindle-cell, round cell, or alveolar sarcomata. Occasionally they produce no symptoms, but may lead to difficulty in swallowing and cause pain. Occasionally a tumor extends to the air-passages, usually shortly before death. (Livingood.) The tumor may cause such complete obstruction of the œsophagus that the patient dies of starvation.

(Chapman.) Varicose veins may accompany the tumor and, by rupturing, cause death. (v. Notthaft.) Sarcomata may be pedunculated or polypoid. (Albrecht.)

Diagnosis.—In all the forms mentioned of new growths œsophagoscopy should be carried out if there are symptoms pointing to disease of the œsophagus, particularly if obstruction is found on conducting examination with bougies. Only by this method (œsophagoscopy) can a positive diagnosis be made, especially if portions of tissue can be removed, otherwise it may be impossible in some cases to differentiate from carcinoma.

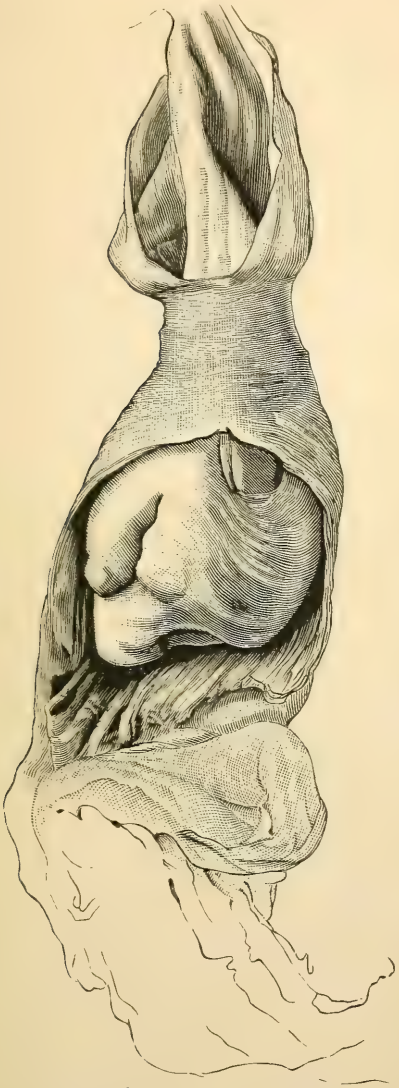
Treatment.—Cauterization might be employed in case of smaller tumors. Pedunculated tumors may be excised, as described under polypi. Finally, where there is marked stenosis leading to inanition gastrostomy must be considered.

Polypi of the Œsophagus.—For practical reasons pedunculated tumors of the œsophagus have been classed as polypi. They are rather rare. The pedicle is usually attached in the region behind the cricoid cartilage—that is to say, the entrance of the œsophagus—in most cases on the anterior wall, usually in the median line, but occasionally a little to the left side. (Zenker.) Sometimes the pedicle is attached lower down. Under such circumstances it may be assumed that in the course of time, as a result of traction on the tumor, the pedicle undergoes a change in its position downward. (König.) In rare cases such pedunculated tumors are situated in the lower portions of the œsophagus, at the level of the bifurcation or nearer the cardia, but in such cases the tumors are usually provided with a broad pedicle. They are usually fibromata, with cavernous spaces filled with circulating blood ("erectile connective-tissue tumor"). Fibromyomata, myomata, and myofibrolipomata may occur in the form of polypoid tumors. They are usually pear-shaped, originating in the submucosa, and covered with mucous membrane. The surface of the larger tumors especially is frequently ulcerated as a result of irritation from particles of food. The time required for the growth of polypi varies. Sometimes they grow rapidly (six months, Schendricowski); occasionally they are only noticed for a few days (Koch). Polypi are found mostly in males of advanced years (Zenker); they vary in size, occasionally becoming formidable (Minski, 14 cm.).

Symptoms.—Small polypoid tumors cause no symptoms. Larger ones may produce much difficulty in swallowing. Some patients note that they can swallow fluids more easily than solids. This is due to narrowing of the lumen of the œsophagus. There may also be nausea and regurgitation of food. Frequently between meals there is a sensation as of a foreign body in the throat; occasionally this is accompanied by gagging and attacks of spasm of the throat. If the tumors attain a large size, there may be difficulty in breathing where a polypus which ordinarily hangs down is thrown into the entrance to the larynx. In this way it may reach the cavity of the mouth and be torn or bitten off by the patient, or it may even hang out of the mouth

(Fig. 36, case of Minski). Polypi occasionally excite indefinitely localized pain. As distinguished from carcinoma, there is an absence of glandular metastases in the neck, and in most cases, owing to the fact that the tumor does not decompose, there is absence of fetor. In some cases the polypus can be felt in the neck as a movable tumor which, in distinction to diverticulum, cannot be emptied by pressure; nor will remnants of food appear in the mouth.

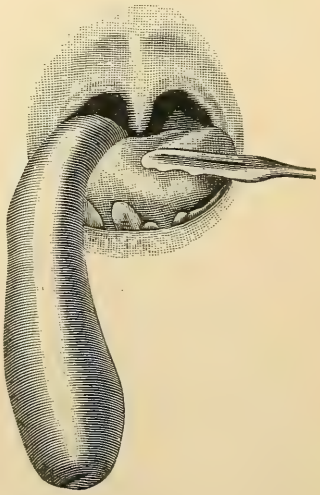
FIG. 36.



Large polypus of the œsophagus.

Diagnosis.—There are no reports of œsophagoscopic examination in cases of polypi. It is to be assumed, however, that examination with the œsophagoscope would reveal the situation and the size of the pedicle, even were it impossible to inspect carefully the tumor itself. Examination with bougies offers no definite information. Middledorpf has

FIG. 37.



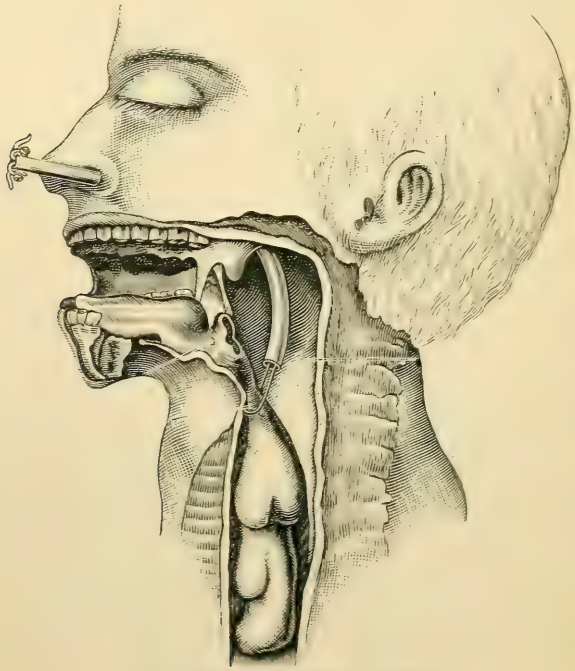
Polypus of the œsophagus. (Minski.)

mentioned that the bougie may be caught at one moment and easily passed into the stomach at the next, which may cause one to suspect a diverticulum. The same may happen in carcinoma.

Acting on the experience that polypi are occasionally thrown up

into the mouth, it has been suggested first to administer apomorphine (Cheatham), and if in this way or without the use of apomorphine the tumor can be reached from the mouth, to grasp it with a Muzeux forceps and to divide the pedicle. This is most simply accomplished with scissors. If the pedicle is narrow, this can be done without previously ligating it (Koch); if it is broad, after passing a ligature (Middledorpf, Warren, Lennander). In the same way the tumor may be removed by means of a galvanocaustic loop or with an ordinary cold snare. If the presence of a polypus has been positively determined, its removal through the neck might be considered. After performing œsophagotomy the tumor could be readily excised at its

FIG. 38.



Large œsophageal polypus. (Dallas.)

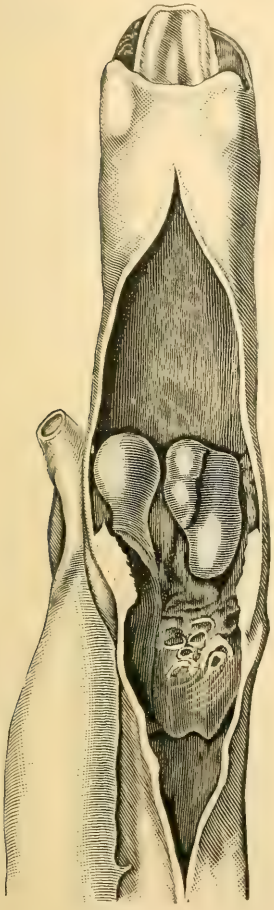
base. In those rare cases in which the pedicle of the tumor is situated lower down in the œsophagus the author would recommend its removal with the aid of the œsophagoscope. The tumor should be grasped by forceps constructed like foreign body extraction forceps, but provided with jaws like those of the Muzeux clamp. The tumor can then be removed by a specially constructed galvanocaustic loop, and finally the tube, forceps, and tumor withdrawn together.

Occasionally asphyxia has rendered immediate tracheotomy necessary. In the case of deep-seated tumors situated low down gastrostomy has been found necessary. (Ogle.) This would be necessary only where removal of the tumor through the œsophagoscope was impossible.

Carcinoma of the Œsophagus.—Carcinoma is the commonest new growth of the œsophagus; in fact, it is the most frequent disease of the latter. It may occur as a primary or secondary tumor. Secondary tumors are usually caused by direct extension from neighboring organs or through inoculation with secretion of carcinomatous ulcers of the upper digestive tract situated higher or lower. True metastases resulting from carcinoma of other organs have not been observed in the œsophagus.

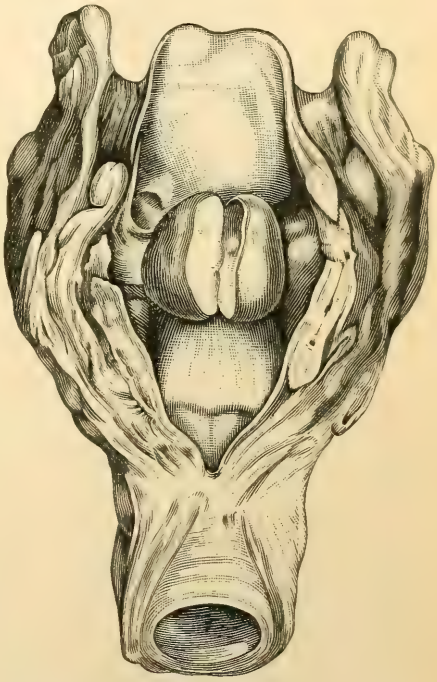
Of carcinomata in general, carcinoma of the œsophagus is fifth in frequency, constituting 5.3 per cent. of all carcinomatous disease. (Heimann.) The male sex is more frequently affected (72.88 per cent.). Women who suffer from this disease generally belong to the poorer classes. As is true of carcinoma in general, it occurs in advanced life. But carcinoma of the œsophagus has been observed in a girl nineteen years old (Heimann), in a girl twenty-three years old (Stewart), and in a man thirty-one years old (v. Hacker); however, it is rare under forty years of age (5 per cent.), being found most frequently after fifty years (71 per cent.).

FIG. 39.



Œsophageal polypi.

FIG. 40.



Polypus of the upper portion of the œsophagus.

Carcinoma of the œsophagus generally occurs as the squamous cell variety. Instances of cylindrical cell carcinoma originating in the glandular epithelium have been described. The colloid form has also been observed. (Butlin, Coats, Fischer.) Carcinoma usually occurs in the form of an island or a girdle (Zenker), but several areas may be attacked at the same time. Not infrequently a point situated lower down is subsequently affected. Direct inoculation may be produced by swallowing fragments of carcinomatous tissue or by manipulation with bougies. These tumors may become so large that the entire œsophagus is involved in the carcinomatous process (cases of Baillie, Ribbentrop, Petri, Zenker, Gernert, and Narath). It is possible that in such cases transmission occurred along the lymphatics.

FIG. 41.

Carcinoma of the œsophagus.

Carcinoma is generally situated at the constrictions corresponding to the cricoid cartilage, bifurcation of the trachea, and the hiatus of the œsophagus, which favors the view that there is some connection between carcinomatous proliferation and repeated irritation, as the latter would be most severe at such portions of the œsophageal wall.

As strictures are found at these sites, it is possible that carcinoma develops in a cicatricial stricture or in any other scar, such as may follow the lesion produced by a foreign body. Absolutely unquestionable observations do not exist.

The statements formerly made regarding the frequency of carcinoma at different levels were contradictory (Mackenzie found that carcinoma was most frequent in the upper third; other observers found it most frequent in the lower third). At present there can hardly be any doubt that the site of the bifurcation is the favorite site for carcinoma.

v. Hacker found that in 100 cases of carcinoma of the upper digestive tract, corroborated by œsophagoscopic and microscopical examination, the cervical portion was involved in 10 cases, the region of the bifurcation in 40 cases, the hiatus in 30 cases, the cardiac end of the stomach in 20 cases. Including 31 cases of gastrostomy for carcinoma

in which the site was positively determined, the 131 cases of v. Hacker are divided as follows: 13 in the cervical portion, 9.92 per cent.; 53 in the region of the bifurcation, 40.46 per cent.; 36 in the hiatus, 27.49 per cent.; 29 in the cardia, 22.13 per cent.

Taken together carcinoma of the hiatus and of the cardia would give the highest figure, 49.62 per cent. The fact that these two forms are not sharply distinguishable explains the former statement that the lower third of the œsophagus is more frequently diseased. Attention was first drawn to this by v. Hacker.

A rare case of carcinoma has been described (Newton Pitt) which developed in the floor of an œsophageal diverticulum. Carcinoma frequently develops also in the vicinity of traction diverticula. (Ritter.)

A predisposition to and an incidental cause in the occurrence of carcinoma must be distinguished. The former is supposed to be due to descent from tuberculous ancestry. Carcinoma of the œsophagus and pulmonary tuberculosis are not infrequently associated. The question suggests itself, whether carcinomatous cachexia does not prepare a suitable soil for phthisis; and conversely carcinoma has been observed to develop in tuberculous ulcers. (Cordua, Pepper, Edsall.) Heredity of carcinoma has been proved in only a few cases. Individual causes were thermal, chemical, and mechanical irritation sufficiently powerful to cause productive processes of the mucous membrane. (Zenker.) The constant use of concentrated forms of alcohol has been held responsible; also rapid eating of too large or too hot portions of food; above all, hard foreign bodies (pieces of bone). Occasionally leucoplakia has been observed in the œsophagus similar to that of other mucous membranes, coincident with carcinoma of the œsophagus. (v. Hacker, Knaut.) As carcinoma develops in other situations where there is leucoplakia, it is possible that here also carcinoma may develop on the base of a leucoplakia. Œsophagoscopy offers the best means of determining the manner of development of carcinoma.

Symptoms.—The most prominent symptom of carcinoma of the œsophagus is dysphagia. The manifestations are those of a slowly advancing stenosis.

Carcinomatous infiltration causes a rigidity of the canal, in consequence of which peristalsis is impaired. Marked dysphagia may therefore exist even where there is only a slight stricture. At the onset of the disease solid particles of food are caught, and must be dislodged by swallowing water. In the course of time particles of food are regurgitated, fluids descending with a gurgling sound. Semisolid food still passes the constriction. Finally only fluids can be swallowed. According to the level at which stenosis is situated, regurgitation takes place immediately or some time after eating, when a greater quantity has accumulated. This regurgitation may take place quietly and is very different from vomiting. Particularly in the later stages there are gagging and retching, which are extremely annoying to the patient. This is particularly true in regard to the tough mucus which accumulates above the stenosis, but infrequently mucus is mixed with streaks

of blood, to which the patient himself is apt to draw attention and which point to existing ulceration. Decomposition of the tumors causes the mucus to become putrid and ichorous, the patient suffering from fetor. Occasionally particles of tumor are mixed with the mucus; such an occurrence may cause the symptoms suddenly to improve for a time. Food can again be swallowed, and consequently the general condition is improved. If a strip of mucous membrane 1 cm. wide remains free from carcinoma, there may be no difficulty in swallowing. (Liechtenstern.)

As a rule carcinoma of the œsophagus produces pain. The patients complain of a sense of burning or pressure in the throat or chest, particularly while swallowing. In this connection there may be painful spasm. (v. Ziemssen.) Pain may be severe even before there is dysphagia. (Hamilton.) The pain is described as drawing or tearing in character; it is frequently perceived in the back, radiating thence to the shoulders and back of the neck. Pain has no diagnostic value, as it may be absent in some cases. Furthermore, the majority of patients do not refer the pain to the site of disease. According to v. Ziemssen, the occurrence of pain at night is of greater significance.

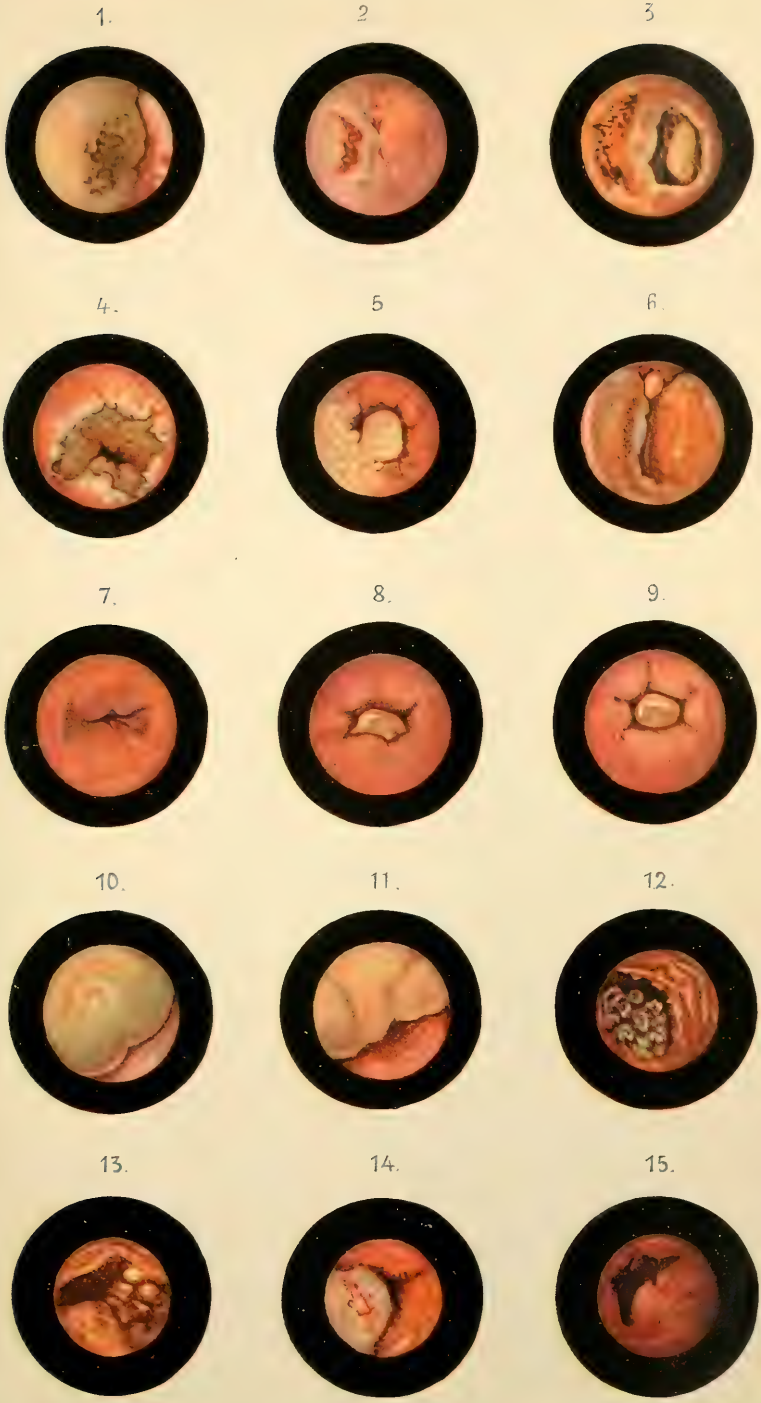
Emaciation and exhaustion are at first caused by dysphagia; later they result also from the malignant pathological process.

Marked inanition occurs in case of cicatricial stricture; but in carcinoma there is in addition hectic fever, caused by the absorption of products of decomposition resulting from necrosis of the tumor. Swelling is found only in tumors of the cervical portion. In most cases swelling is due to tumor of the lymph-glands, which may undergo softening and form abscesses. As in the case of other tumors of the thoracic cavity, particularly those of the posterior mediastinum, there are occasionally found hard glandular swellings above the clavicle on the side corresponding to a deep-seated carcinoma of the œsophagus or the cardia of the stomach.

v. Hacker reports a case in which the presence of a hard lymph-gland the size of a bean in the left supraclavicular fossa led to the diagnosis of carcinoma of the cardia, although other surgeons had never been able to find a constriction when examining with bougies.

There are a number of symptoms that occur in cases of carcinoma of the œsophagus which indicate that the disease has made considerable progress. In about one-sixth of the cases there is contraction of the corresponding pupil. (Hitzig.) As a rule the left pupil is affected. This symptom is due to pressure on the sympathetic nerve. It is not necessarily accompanied by recurrent paralysis. The latter symptom does not so much indicate the seat of carcinoma, but points to involvement of the lymph-glands, especially where the right recurrent nerve is affected. The left recurrent nerve, which extends lower down, may become surrounded by carcinoma. Adhesions with the recurrent nerves may lead to attacks of dyspnœa. The latter may become so severe that tracheotomy becomes necessary. This may happen before signs of dysphagia have appeared, so that the symptoms are

PLATE II.



Views of Carcinomata of Œsophagus seen in Œsophagoscope at Various Depths. Figs. 7, 9, and 14. Carcinoma of Cardia of Stomach at Depths of 43½ and 46 cm.

referred to the larynx. (Goisque.) Even carcinoma in the region of the bifurcation may lead to dyspnœa. In this event there is said to be a difference in the respiratory function of each lung.

If carcinoma advances toward the vertebral column, compression or destruction of the spinal cord may lead to paraplegia, either after rupturing through the vertebræ or by advancing along the intervertebral foramina. If at this time the symptoms of stenosis of the œsophagus are not marked, they may simulate those of caries of the spine. (Page.) In a number of instances vasomotor and trophic disturbances of the nails were observed accompanying existing carcinoma of the œsophagus. (Bard.)

Diagnosis.—Certain important diagnostic points may be derived from the history. Very frequently the absence of any traumatic or other etiological factor, combined with slowly increasing manifestations of stenosis, would be more in favor of neoplasm than cicatricial stricture. Taking into consideration the age of the patient, if the latter is of the male sex and the above-mentioned symptoms are present, character of dysphagia, emaciation, cachexia, a diagnosis of malignant new growth will be correct in 9 out of 10 cases. (Butlin.)

On palpating the neck a tumor or indistinct induration may occasionally be felt. This may be caused by the primary tumor; but as a rule these swellings are only glandular metastases. Examination with bougies may corroborate the former probable diagnosis, and will offer information as to the existence and site of the stenosis.

However, examination with bougies possesses certain disadvantages; thus no obstruction may be found even where carcinoma is present. This may be due to the fact that the tumor is still small, and the bougie glides past if the latter is not skilfully advanced, and unless every projection of the œsophageal wall is carefully palpated. Examination may be negative also where the tumor has undergone necrosis and the portions projecting into the lumen have become destroyed. If a hollow bougie is employed in conducting the examination, and provided the carcinoma has become ulcerated, particles of tissue may remain caught in the fenestrum of the instrument and the diagnosis positively determined by the examination of these fragments. Kelling constructed his instrument with a guarded sponge for the purpose of removing portions of tumor for examination. The safest way of performing exploratory section is by the aid of the œsophagoscope. The precaution should be observed, however, to grasp only with forceps tabs of tissue projecting into the lumen, and not to cut too deep, in order to avoid producing severe hemorrhage. If hemorrhage does occur, the bleeding site should be touched with cotton wet with ferric chloride, silver nitrate, or ergotine "Bombélon." (v. Hacker, Rosenheim.)

Œsophagoscopy is certainly the safest aid to diagnosis, though it must be admitted that in the initial stages before ulceration has ensued or before distinct cancerous protuberances can be recognized one

must frequently be satisfied with a probable diagnosis. In many cases this method will enable the surgeon to make an early diagnosis of carcinoma, and to differentiate carcinoma from other diseases. Latent carcinoma of the œsophagus can probably always be recognized on direct inspection.

The œsophagoscopic findings, as described by v. Hacker, are the same for the different levels of the œsophagus. In the initial stage there is infiltration of the mucosa. This can be recognized by the fact that at the site of infiltration the wall is rigid and does not move during respiration; on inspiration the lumen of the œsophagus does not open. Later, a more circumscribed portion bulges forward. The mucous membrane covering the latter is paler or more cyanotic; the lumen has the form of a slit. There may also be numerous very small papillary excrescences distributed over an unchanged mucous membrane, producing an appearance like that of a cat's tongue. Where carcinoma invades the submucous tissues, contraction of the latter may throw the mucous membrane covering this portion into fixed longitudinal folds. At the same time there may be the formation of a funnel, which, in distinction to that found in cicatricial stricture, does not show a bulging similar in appearance to the mouth of the cervix when the tube is advanced, and which is characterized furthermore by the absence of cicatricial tissue. The escape of bloody mucus from the contracted lumen would point to ulceration lower down. Frequently in carcinoma there are areas of leucoplakia very similar in appearance to those of the tongue. During the transition into ulceration epithelial vesicles frequently occur, which later develop into confluent ulcers. Carcinomatous proliferation takes place in the floor of these ulcers. They often present the appearance of a raspberry. At this stage the border of the mucous membrane is frequently notched, bleeding easily. If transition from normal mucous membrane to ulceration progresses circularly at the same level, the picture will be that of a ruptured drum-head. The ulcer itself is generally covered with reddish-gray granulations, the latter showing a yellowish or whitish deposit; more rarely they appear red, as if freshened.

Exploratory resection of such a projecting, fluttering portion with œsophageal forceps will render a positive diagnosis possible. If the ulcer invades the deeper tissues, the muscular layer is exposed, showing a loop-like arrangement. It is notable that not infrequently carcinoma of the lower portion of the œsophagus extends directly to the stomach, while carcinoma of the cardia extends to the œsophagus. This secondary extension to the œsophagus will not exert any influence on the course of the disease, as the symptoms of existing stenosis would only be increased. Such carcinoma of the cardia may cause difficulty in swallowing and lead to cachexia just as carcinoma of the œsophagus does. Frequently where it is believed that a bougie has been passed into the stomach without meeting obstruction the obstruction was actually situated lower down. It may be assumed with a certain degree of certainty that where carcinomatous stenosis is present in a

male, and is situated more than 40 cm. from the teeth (up to 45 cm. or further), we usually have to deal with carcinoma of the cardia. In this connection it is interesting to note a case described by v. Hacker in which carcinoma of the cardia extended to the œsophagus, beneath the mucous membrane, and in which autopsy showed that cylindrical cell carcinoma was situated beneath the squamous cell epithelium of the œsophagus.

Fig. 42.

Carcinoma of the œsophagus involving the adjacent portion of the stomach.

Prognosis.—The prognosis of carcinoma of the œsophagus is very unfavorable. Sooner or later it causes death, and so far it has been impossible to effect a cure, even by resection.

The average duration of the disease is one year, or two years at the most, counting from the onset of the symptoms. Frequently death takes place within a few months, or even within six or seven weeks, after the first manifestations of the disease. Still, a patient observed at the Innsbruck clinic died four years after a diagnosis of carcinoma had been positively determined by œsophagoscopic and microscopical examination. Either death takes place slowly from inanition and carcinomatous cachexia, from perforation, with subsequent septic phlegmon (ichorous pleuritis), or with the typical picture of pyæmia. Where there is rupture into the air-passages death results from pneumonia or gangrene of the lungs. Death takes place rapidly and suddenly where carcinoma ruptures into large vessels. Erosion of tumors may take place through secondary glandular tumors and lead to external hemorrhage. If carcinoma involves larger veins, as the azygos vein, for instance, thrombosis may extend from the latter to the heart, and thus death may result from the latter or from cerebral embolism. (Klemperer, Leichtenstern.)

Perforation into the air-passages is the most frequent, and more

commonly takes place into the trachea or into the left bronchus. Less frequently rupture takes place into the lungs; rupture into the pleura is still less frequent. In about 60 per cent. of the cases carcinoma produces metastases. (Petri, Zenker.) The neighboring lymph-glands are first involved. Tumors of the cervical and supraclavicular glands are frequently found, the latter most frequently on the left side. Glands in the mediastinum undergoing decomposition may cause abscesses. Metastases of the skin are rare. (Charles, Levt, Pigger.)

Treatment.—The treatment comprises the following operative methods: resection of the œsophagus, œsophagostomy, gastrostomy. The non-operative methods: dilatation with bougies or stretched rubber drains, and dilatation by permanent tubage.

Resection of the Œsophagus.—In the majority of cases carcinoma of the œsophagus is not accessible to radical treatment. Such radical treatment always requires resection. Even transitory results have been obtained only in carcinoma of the cervical portion. Considering primary carcinoma alone, resection was performed in only 15 cases, of which 5 (or 33.33 per cent.) died as the result of the operation. The further below the cricoid cartilage carcinoma is situated, the more dangerous is operation and the less prospect of success. Possibility of resection will be determined by the extent of the tumor and the strength of the patient. It is out of the question to speak of a radical method of treatment, even if in single instances patients have lived some time after operation (Czerny, one and a quarter years; Mikulicz, eleven months; Garrè, one year). All died from recurrence.

In a number of cases preliminary operations were performed, such as tracheotomy, œsophagotomy, gastrostomy.

Only under exceptional circumstances will tracheotomy enter into consideration, where, for example, it is impossible to determine whether carcinoma originated in the larynx or in the œsophagus. The relations are different where it has been determined that carcinoma extended from the œsophagus to the air-passages, and where a portion of the latter must be removed. De Quervain is correct when he recommends opening the air-passages, even in these cases at the end of the operation, in order to prevent the entrance of blood into the air-passages, and infection of the wound with mucus from the trachea (putrid bronchitis being present in the majority of cases). Cough excited by the presence of the canula interferes with the operation.

Œsophagotomy for diagnostic purposes should be avoided, as exploratory section can be performed through the œsophagoscope: and if resection is performed several days later, it is necessary to work through cicatricial tissue. Gastrostomy before the radical operation is well adapted for the purpose of improving general nutrition. It offers the great advantage that for a time feeding with the stomach-tube can be avoided, and thus the wound be allowed to heal without interference. If, as in the case of Quervain, the œsophagus cannot be reconstructed, the fistula can be employed to feed the patient during the rest of his life.

The operation is performed in the following manner: An incision is made along the inner border of the sternomastoid. This should be sufficiently long to provide ample room for inspection. It should be made on either the right or the left side according to the seat of the tumor, or it can be made on one side, and then extended from the clavicle in a curve to the other side. In order to obtain more space the sternal attachment of the sternomastoid may be divided. (De Quervain.) The œsophagus can then be exposed as in œsophagotomy. If one of the lobes of the thyroid gland has been infiltrated with carcinoma, or if it cannot be sufficiently displaced on account of struma, it is removed. In such cases the recurrent nerve must be carefully watched for. Resection should be carried well into sound tissue, not too near the boundary of the tumor; sometimes, however, this has been found impossible. Occasionally a bridge of mucous membrane may be allowed to remain, especially at the posterior wall. This is very important in bringing the ends of the œsophagus together. If, after circular resection, the cut ends of the œsophagus are not more than 4 cm. apart, it may be possible under circumstances to suture them directly (according to the method of circular enterorrhaphy, in two layers). (Czerny.) Otherwise attempts must be made to suture the lower end into the lower angle of the wound, and subsequently to perform an œsophagoplasty. If resection has been carried well down into the thorax (De Quervain) (as far as the level of the arch of the aorta), this will be impossible; the lower end can then be tied off and allowed to drop back. Graeve sutured both ends of the œsophagus into the cutaneous wound.

After-treatment is important. Special care should be taken to prevent: (1) mediastinitis; (2) foreign body pneumonia; (3) secondary hemorrhage. If gastrostomy has been previously performed, danger of mediastinitis from the entrance of particles of food need not be feared. In order to prevent the retention of secretion, the dressing should be frequently changed (twice a day in the beginning). It is recommended to have the foot of the patient's bed elevated. If the larynx and trachea are preserved, foreign body pneumonia is not very liable to occur. If those structures were also resected, exact suturing of the trachea and frequently changing the dressing offer the greatest protection, particularly if the patient is fed through a stomach-tube. This treatment, in addition to careful ligation of all divided vessels, is the most efficient means of preventing secondary hemorrhage, as thereby suppuration, which might be produced by the presence of particles of food, can best be avoided.

Resection is frequently followed by marked cicatricial stricture. (In Czerny's second case the patient was obliged to carry a stomach-tube at night for the purpose of dilatation.) This is especially liable to happen where, on account of much tension, direct union can be only incompletely effected. In such cases œsophagoplasty is preferable if at all possible. In carrying out this operation, a portion of the œsophagus is replaced by external skin. If carcinoma has advanced very far,

so that the larynx must also be removed, the mucous membrane of the latter may be employed for plastic purposes, provided it is healthy. (Garrè.) The operation is performed in two stages. According to v. Hacker's description, rectangular skin flaps are first fashioned; those are sutured to the posterior bridge of mucous membrane, provided this was preserved. Where that is not the case, they are sutured to each other. If larynx and trachea were resected at the same time, a bridge-flap may be formed (unless this is rendered impossible on account of the incision employed for resection). Above and below, these flaps are sutured to the posterior circumference of the lumen of the œsophagus or the lumen of the pharynx, and thus a posterior œsophageal wall is formed. At a later stage the pedicles are divided on the right and left side and sutured together to form a canal, and the latter sutured to the anterior circumference of the lumen of the œsophagus or lumen of the pharynx. Above this the skin is sutured, after having been loosened by dissecting away laterally. This plastic operation has been successfully employed a number of times (Poulsen, Hochnegg, Narath, Garrè). For smaller defects a pedicle flap can be sutured with the skin side turned in. (Mikulicz.)

In the thoracic portion resection was attempted only once.

Relm undertook to expose the œsophagus from behind in a man forty-nine years old, on account of disturbed digestion resulting from the flow of ichorous secretion from carcinoma into the stomach. (The technic of posterior mediastinotomy is described elsewhere.) In the above case no tumor could be seen nor felt, and after the pleura had been repeatedly injured, the operation had to be abandoned; death occurred six days later. The cases operated by this method for cicatricial stricture died. (Relm, Llobet.) Mikulicz removed the entire thoracic portion of the œsophagus, which was the seat of carcinoma, through a cervical and abdominal incision. The patient died shortly after.

Under these circumstances surgeons are not justified at present in undertaking the resection of the thoracic portion for carcinoma of the œsophagus, the more so as they are unable to perform a radical operation because the diagnosis is seldom made sufficiently early.

According to Levy's and Biondi's attempts, and according to the unfortunate experience of Mikulicz, resection of the cardia or the abdominal portion of the œsophagus is a more serious operation than resection of the thoracic portion.

ŒSOPHAGOSTOMY.—The technic of œsophagostomy was described on page 48; it is applicable in carcinoma situated high up, where the œsophagus can be opened below the stricture. The results of this operation are not encouraging. Not infrequently there followed ichorous infiltration of the connective-tissue spaces surrounding the œsophagus. This arose from the œsophageal fistula, and was caused by the products of decomposition of necrotic carcinomatous tissues. It appears doubtful whether feeding through an œsophageal fistula is less annoying to the patient than through a gastric fistula; the latter

procedure is certainly easier for the patient to carry out himself. Œsophagostomy deserves consideration only where there is a prospect that resection can be completed, and where it is only discovered at the time of operation that carcinoma is too extensive, and where it is not desirable to make a second incision. Otherwise gastrostomy is preferable.

Gastrostomy.—Gastrostomy is indicated where the patient cannot obtain sufficient nourishment by mouth, as shown by loss in the body weight. If the latter is not constant or decreases, gastrostomy should be performed even if the patient is still able to swallow fluids. (v. Hacker.) It is necessary, of course, to employ a method that can be rapidly and easily carried out, and which will effect complete closure of the fistula (method of Witzel, Frank, Marwedel, Kader); the formation of a sphincter according to v. Hacker, or, still better, combining this method with Lucke's of forming a canal.

The earlier the operation is performed, the better will be the results of gastrostomy. In other words, the operation should be performed as soon as the diagnosis has been positively made. But even where the diagnosis is doubtful, gastrostomy may save the life of a patient in those cases, for example, in which there are fissures in the region of the hiatus of the œsophagus which may produce manifestations of stenosis similar to those caused by carcinoma. It is true that gastrostomy cannot check the progress of the disease, but it may inhibit ichorous decomposition, which is caused by the retention within the ulcer of putrid remains of food. As a result of the operation the carcinoma may grow less rapidly, as continuous irritation caused by food passing through the constriction, and the pain associated with the latter, are removed. About the only contraindication to gastrostomy is putrid bronchitis (v. Hacker), as this would indicate extension of carcinoma to the air-passages. Unfortunately patients and physicians frequently decide upon operation too late, and for that reason statistics show a high mortality. The operation was generally performed when the patient was *in extremis*, when no other method would have availed. If gastrostomy is performed at the proper time, life may be prolonged for months, or for more than a year; otherwise for from three to four months. The patient is made more comfortable, not being allowed to go hungry all the time.

The author had the opportunity of observing several cases at the clinic in Innsbruck in which the patients had been reduced to a miserable condition, but rapidly recovered and were able to work for months. These circumstances are certainly in favor of the operation, which is freer from danger if carried out aseptically, especially if local anæsthesia is employed.

Dilatation with Bougies and Treatment by Permanent Tubage.—Treatment with bougies is very generally employed, especially by the general practitioner, for the purpose of dilating carcinomatous stricture. This is usually successful, as soft carcinomatous tissue readily yields. It cannot be denied that this method is fre-

quently unavoidable, as the patients do not consent to gastrostomy. At the same time it should be borne in mind that the use of bougies produces mechanical irritation, and that the growth of tumors may be excited thereby. It must be admitted also that perforation into neighboring organs may occur during the procedure (Clauditz), though others again have not observed such an accident among many cases (Schmidt).

Dilatation may be performed with conical or cylindrical bougies. Occasionally bougies can only be passed with the aid of the œsophagoscope, for the first time at any rate. Dilatation by means of stretched drainage-tubes is the best and most efficient method. (v. Hacker.) The technic of the latter has already been described. As these drains are only allowed to remain in place for several hours every few days, there is less danger of perforation than where permanent tubage is employed. The latter is preferred by some. (Symonds-Gangalphe, Leyden, and Renvers.) Hard-rubber tubes are employed, or in the case of stricture situated high up, elastic tubes, which can, however, be introduced only after dilatation has been sufficiently effected by passing bougies. In order that they may not become obstructed, fluid diet should be given; they are attached to a thread which is fastened to the ear or to a tooth. They must be worn for weeks or even months. This may result in some very unpleasant accidents. The thread may tear or be swallowed. The tube may be displaced; it may be surrounded or obstructed by carcinomatous proliferation, etc. The thread in the mouth is very annoying to the patient.

In some cases cauterization might be considered. This should be performed by the aid of œsophagoscopy. A specially constructed thermocautery might be employed (v. Hacker), or a galvanocaustic loop. Rosenheim has constructed a porcelain burner for this purpose.

The application of medicaments may also be occasionally employed for the purpose of alleviating suffering. Injecting 1 to 2 c.c. of a 1 to 4 per cent. solution of silver nitrate produces a disinfecting action rather than a caustic one. (Rosenheim.) Eight to ten drops of a 1 per cent. solution of silver nitrate may be given internally three times a day. (v. Hacker.) For the purpose of dissolving the accumulations of tough mucus a solution of sodium bicarbonate (10 : 100) should be frequently administered. The latter occasionally relieves even severe dysphagia temporarily. (Fritsche.) For the pain narcotics are recommended, at first extract of belladonna, aqua amygd. amar. Rosenheim injected 1 to 2 c.c. of a 3 to 6 per cent. solution of eucaine through an œsophageal syringe. v. Hacker orders 8–10 drops of a mixture of extract of nux vomica (0.1) and aqua lauraceras. (10.0), three times a day. Recently heroin muriate has been successfully employed at the clinic in Innsbruck; 10 drops of a 1 per cent. solution (0.5 grain) were given three times a day.

INJURIES AND DISEASES OF THE ABDOMINAL WALL.

By Prof. STEINTHAL.

In injuries of the abdomen, as in inflammations, the abdominal wall plays a secondary part. The force usually expends itself on the abdominal organs rather than on the wall; and the inflammatory process is apt to be marked in the abdominal organs and to extend secondarily to the wall. Still cases occur in which traumatism is confined to the abdominal wall, or in which inflammation begins in it.

With new growths the conditions are different and primary tumors of all sorts occur in the abdominal wall. This is especially true of the umbilicus and its immediate vicinity, a fact which occasions no surprise when one considers the different kinds of tissue which join at this point, and that at different periods of development the intestine and urinary bladder have both maintained an intimate relation with the umbilicus. On this account, and because its inflammatory processes have their own peculiarities, it is well to consider the diseases of the umbilicus apart from those of the rest of the abdominal wall.

CHAPTER V.

INJURIES OF THE ABDOMINAL WALL.

SUBCUTANEOUS CONTUSIONS AND TEARS OF THE ABDOMINAL WALL.

The simplest form of injury is the subcutaneous contusion manifesting itself by a circumscribed effusion of blood which for a time may be painful but which is soon absorbed. If the injuring stroke is stronger, some vessels of the subcutaneous tissue may be ruptured and give rise to free hemorrhage. The blood may appear in the anterior surface of the thigh.

If the contusion of the abdominal wall is uncomplicated, pain is

usually slight and of short duration. A greater degree of pain may be due to rupture of a muscle. Palpation when the muscle is alternately relaxed and contracted may reveal the gap due to rupture.

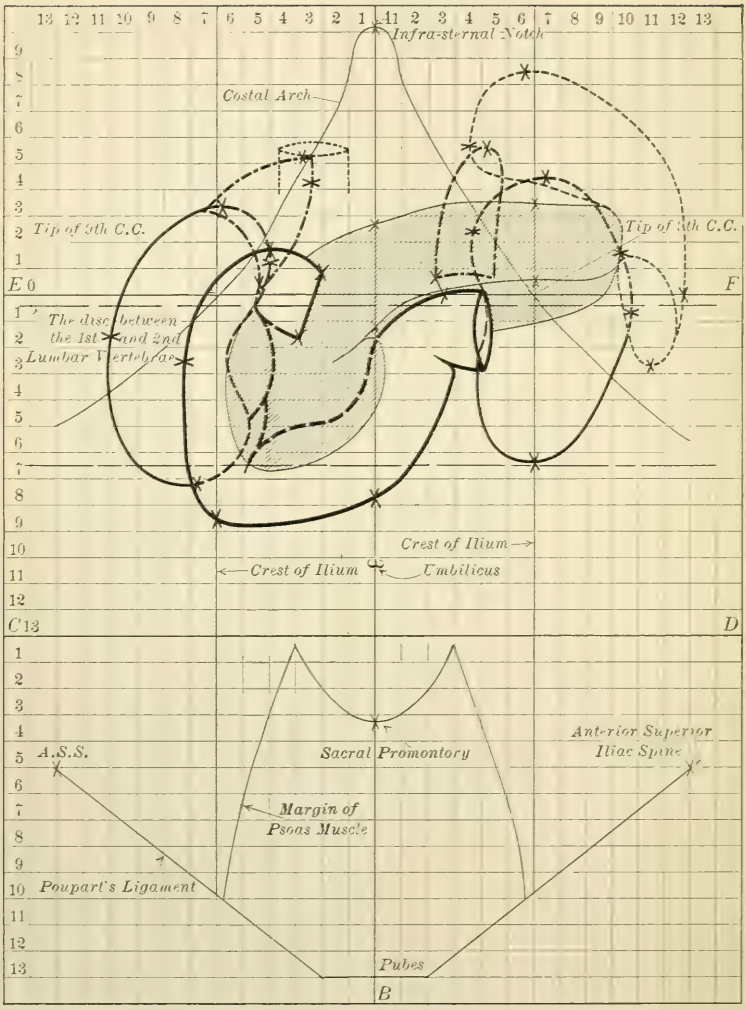
There have been cases in which simple contusions of the abdominal wall were followed by intense shock with feeble pulse and cool extremities, and perhaps even vomiting. Maschka and Templemann reported the occurrence of death after comparatively slight blows upon the abdomen, due apparently to reflex changes in the vasomotor centre of the medulla oblongata. This shock, which is usually of short duration, should be differentiated from internal injury. A like condition is produced by internal hemorrhage; but hemorrhage tends to distend the abdomen and produce dulness in the dependent portions. The latter requires prompt surgical relief, while in shock of the character mentioned no operation is indicated.

Symptoms.—If the symptoms of shock continue or recur after subsiding, and especially if the contraction of the abdominal muscles is not confined to the site of the injury, there is always a possibility of rupture of the alimentary canal. This may happen even though the force is a slight one and there are neither general nor local symptoms to indicate the deeper injury. Such a patient should be kept under observation for at least three days. When the injury is of a more violent form—for example, if the patient has been run over by a wagon or kicked by a horse—he should be kept under observation for at least three weeks, since an injured portion of intestine may slough away days after the accident.

Prognosis.—The prognosis of subcutaneous injury of the abdominal wall is necessarily uncertain, since it is not possible to determine until time has elapsed whether the force has spent itself superficially or whether internal organs have been injured. Prognosis should be especially guarded if at the time of injury the back of the patient was fixed; for example, if he has been run over, or crushed between cars, or in any way held so that the abdominal organs have been pressed against the spinal column or margin of the pelvis. For this reason, force from one side is less destructive than force from the front. A kick of a horse received from in front is frequently complicated by intestinal injury. Such details of an injury are suggestive, but there are no certain clinical signs which will enable the surgeon to make an exact diagnosis in the first twenty-four hours.

Subcutaneous injury is possible without external violence. Thus, the recti muscles may be ruptured by overexertion even if they have not been weakened by alcohol or disease, such as typhoid fever. During convalescence from typhoid fever so slight a muscular exertion as an effort to rise in bed may suffice to rupture one of these muscles. Palpation will reveal the gap in the continuity of the muscle, usually below the umbilicus. In typhoid patients this injury may be followed by suppuration; in other patients the rupture heals without complication. Maydl, who collected 16 cases of rupture of the abdominal recti muscles, found records of rupture of the oblique or transverse muscles in

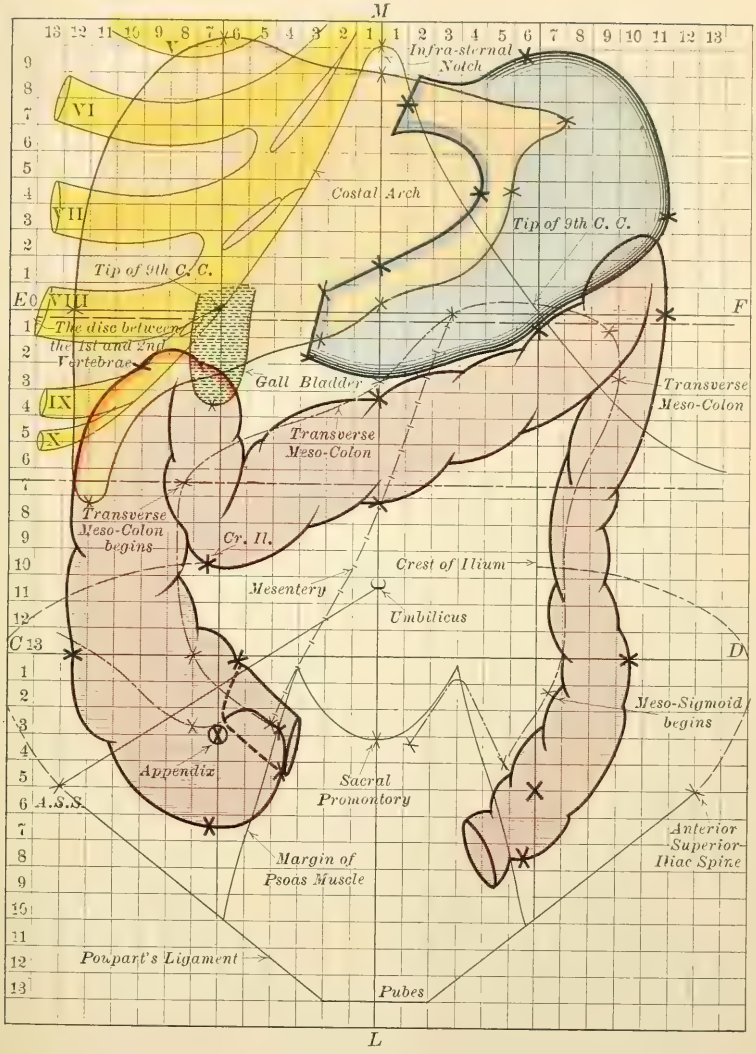
PLATE III.



Outlines of the Deeper Abdominal Viscera.

(From drawing by C. W. Smith (Addison), Brit. Med. Journ., March 16, 1901.)

PLATE IV.



Topographical Anatomy of Abdominal Viscera.

(From drawing by C. W. Smith.)

Lower border of stomach and upper border of transverse colon should be 0.5 cm. lower.

only 3 instances, and in all of these cases the rupture was due to direct violence.

Treatment.—The treatment of uncomplicated contusion of the abdominal wall is simple. The patient remains in bed, and either an ice-bag or hot moist compresses are kept upon the abdomen. If there are symptoms of severe shock, ether or camphor should be injected subcutaneously. If contractions of the abdominal muscles or other symptoms suggest injury of some abdominal organ, an exploratory laparotomy is advisable if the patient's general condition permits. Usually a short incision will suffice to make the diagnosis. Simple contusions are recovered from in a few days, while repair after severe contusion may require four or six weeks to be complete. Even after this time there may be local pain, which is increased by bending forward or backward, or to one side.

Witzel believes that ventral hernia may follow slight rupture of the linea alba due to a blow or backward flexion of the trunk. This opinion is accepted by some surgeons and disputed by others. It may be of importance in connection with accident insurance, and some companies have recognized it as a cause of ventral hernia.

WOUNDS OF THE ABDOMINAL WALL.

Open lacerated and contused wounds of the abdominal wall are produced by a variety of instruments. When the patient is injured by machinery, a portion of the abdominal wall is often torn away, leaving the fascia or muscles exposed. Extensive wounds may also be caused by scalds, acids, or burns. These wounds do not differ from similar wounds elsewhere in the body unless accompanied by shock. Punctured and gunshot-wounds have long been divided into those which penetrate and those which do not penetrate the peritoneal cavity, while the latter are again divided into those which penetrate without injuring any abdominal organ and those in which some internal injury is produced. While these differences are all-important, such a wound should not be probed with an instrument or the finger. If there is reason to suspect from the appearance of the wound or the nature of the injury that the abdominal cavity has been opened, the wound and its vicinity should be thoroughly cleansed and the edges retracted, and if necessary the wound should be enlarged to permit a determination of its extent. If the wound is situated in the anterior portion of the abdomen, local anæsthesia will usually suffice for such an exploration; if it is situated laterally, a general anæsthetic is desirable on account of the thickness of the muscular walls.

If the omentum or intestines protrude from an abdominal wound, the condition is spoken of as a complete traumatic hernia. If such organs lie between the layers of the abdominal wall, the hernia is an interstitial, traumatic one, whereas if they lie between the peritoneum and the abdominal wall, the term properitoneal traumatic hernia is applied.

A wound just above Poupart's ligament may involve the epigastric artery and produce considerable hemorrhage. This vessel runs from about the middle of Poupart's ligament upward and slightly inward and anastomoses with the mammary artery.

A fall upon a picket fence is a not uncommon cause of injury to the abdomen. Madelung reports a case of this character which is well represented in the accompanying illustration (Fig. 43).

While a penetrating wound of the abdomen can hardly be produced by a blow if the abdominal wall is normal, instances have occurred in which the thin wall of a hernia has ruptured as a result of a fall and exposed the abdominal organs.

FIG. 43.

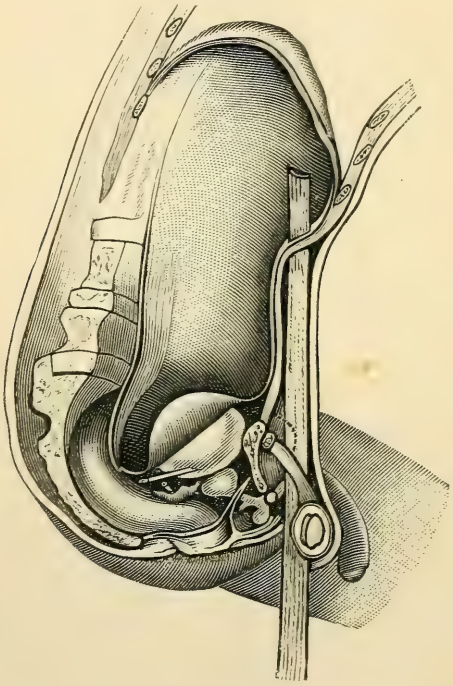


Diagram to show the effect of a fall upon a picket.

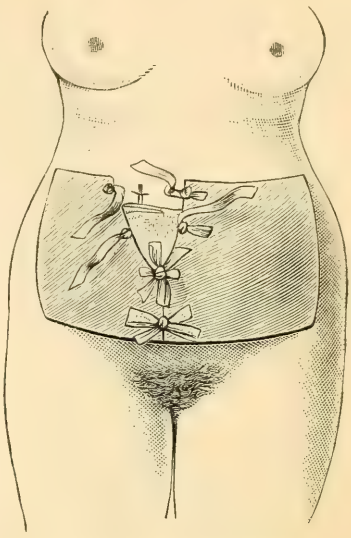
A punctured wound may be complicated by the introduction of bits of clothing, of buttons, or the instrument which caused the wound may break off within it. Such foreign bodies, if they are not removed, will give rise to protracted suppuration.

Prognosis.—The prognosis of punctured wounds of the abdomen rests chiefly upon the presence or absence of complications in the form of injury of the abdominal organs. Wounds of this character which are uncomplicated heal without reaction unless there is primary or secondary infection. Recovery is much delayed if there is a considerable loss of tissue, especially when this is the result of a burn.

Repair is constantly interfered with by the motion of the abdominal wall. Larger wounds are often followed by ventral hernia.

Treatment.—Punctured wounds which do not penetrate the peritoneal cavity should be cleansed and sutured. All hemorrhage should be checked in order to avoid collections of blood, which might lead to suppuration or which might otherwise defeat primary union. Oblique punctured wounds must be split up in order to free them from foreign bodies and to prevent protracted suppuration. Penetrating wounds which are not complicated by injury to any organ should also be sutured, the sides of the wound being approximated by a single row of stitches or by a suture in layers. If the epigastric artery is wounded, both ends of it will require ligation on account of its free anastomosis with the mammary artery. Abdominal organs which present in the wound are to be cleansed with warm sterile salt solution and replaced.

FIG. 44.



Adhesive plaster dressing.

If suppuration occurs in a sutured wound, the stitches should be removed, the wound cleansed, and a dressing wet with a 1 per cent. solution of aluminum acetate applied. Gaping of the wound-edges can be prevented in the following manner (Fig. 44): A broad strip of adhesive plaster is fixed on either side of the wound; the edge of the plaster is bent under and stuck to itself so as to leave a cloth margin about two inches wide along the wound which will not stick to the wound. Several tapes are fastened along these folded edges, and by their aid the abdominal walls can be drawn together in order to prevent gaping of the wound. At each change of dressing these tapes are untied and the edges of the plaster laid back out of the way.

Contused and lacerated wounds should be made smooth. Large gaps in the abdominal wall may be overcome by flaps or by secondary skin-grafting.

FOREIGN BODIES IN THE ABDOMINAL WALL.

Removal of foreign bodies from wounds in the abdominal wall has been spoken of. Needles and small splinters may penetrate the abdominal wall without producing noticeable wounds. Such objects are sometimes inserted by hysterical individuals. Needles and other objects which have been swallowed may pass from the stomach and instestine and appear subcutaneously, especially in the region of the umbilicus. A fecal

fistula may be the result, or the wound in the intestine or stomach may close spontaneously when the object has passed through. If such is the case, the foreign body will be surrounded by an abscess, but there will not be a fecal fistula. Needles may pass from the stomach or intestine without giving rise to either abscess or fistula, escaping notice until they prick the overlying skin.

If a slender foreign body, such as a needle, is discovered, the overlying skin should be punctured and the foreign body removed. Larger and irregularly shaped objects should be removed with care lest adhesions be broken up. The inflammation quickly subsides when the foreign body has been removed.

CHAPTER VI.

DISEASES OF THE ABDOMINAL WALL.

INFLAMMATIONS OF THE ABDOMINAL WALL.

The inflammations of the abdominal wall which are confined to the skin or the tissues immediately beneath it do not require special notice. Most of them are of the nature of cellulitis due to external wounds and infection or to foreign bodies entering the abdominal wall through the skin, or from within the alimentary canal.

The median line of the abdominal wall may be the seat of deep inflammatory processes which develop in two forms:

1. If an inflammation develops within the sheath of the rectus, it is limited by the strong fascia about this muscle so that it cannot spread laterally. Above the umbilicus it is also limited by the transverse fascial bands, beyond which it cannot spread longitudinally. It may, however, spread downward to the symphysis and extend over to the opposite side of the median line. The extent of this swelling is sufficient for a diagnosis. If the patient in a recumbent position is asked to raise his head from the pillow, the rectus muscle will be contracted and the swelling will be seen to lie in front of it; but by this contraction the swelling will also be made immovable, whereas a diffuse suppuration of the subcutaneous tissue is more or less movable whether the recti muscles are contracted or not.

2. Deep inflammation of the other type develops in the loose connective tissue below the umbilicus and between the peritoneum and the abdominal muscles. This retromuscular space is divided into three spaces by the transverse fascia and the thin fascia extending from the bladder to the umbilicus. These three spaces have been called the submuscular, the prevesical, and the preperitoneal space. (Fig. 45.) The cellular tissue which fills these spaces is not only connected together, but also with that in the iliac fossa and in the cæcal region, so that inflammatory processes may easily extend from one region to the other.

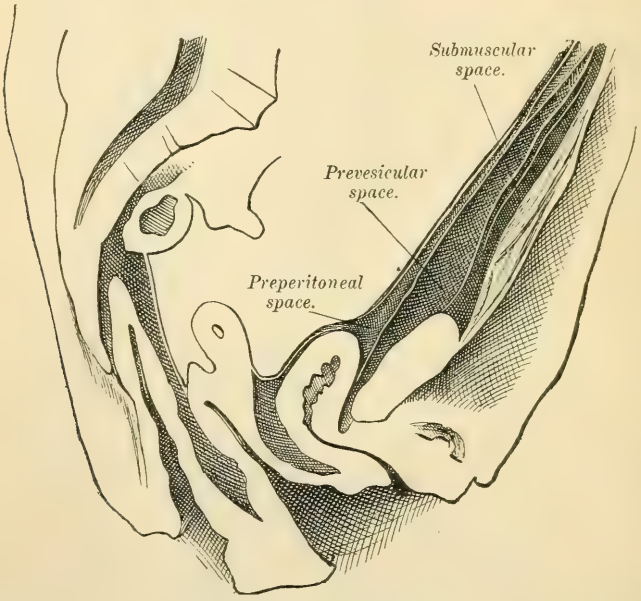
The prevesical space is the most important. If suppuration takes place within it, a rounded swelling is formed behind and above the symphysis which greatly resembles the distended bladder. The bladder is usually involved in the inflammation. Pus may be discharged spontaneously either above the symphysis or into one of the hollow pelvic organs. Suppuration of the submuscular space is situated nearer the umbilicus and seldom reaches the symphysis, nor does it extend into the pelvis. It forms a pear-shaped swelling in the region of the um-

bilicus with the point directed toward the symphysis. Such a swelling may lie on one or both sides of the linea alba. The bladder is not affected. The usual point of rupture for such an abscess is just below the umbilicus.

For practical purposes it is well to look upon the retromuscular connective tissue between the umbilicus and the symphysis as a single space in which inflammation may develop sometimes nearer the umbilicus and sometimes nearer the symphysis.

Inflammation of the median portion of the abdominal wall may be either primary or secondary, and either acute or chronic.

Fig. 45.



Frozen section through the pelvis of the female subject after distention of the arteries by water injected at a pressure of ten feet in height. (Kenke.)

Primary Inflammation.—The inflammation which arises in the sheath of the rectus is of a primary character. Its common cause is a hemorrhage following muscular rupture during convalescence from typhoid. Such hemorrhage is usually situated below the umbilicus and behind the rectus muscle, so that the resulting suppuration may develop in the submuscular space. There is also an inflammation in the prevesical space which may be either idiopathic or traumatic. In the latter case hemorrhage follows a blow upon the lower portion of the abdomen and the blood-clots suppurate. Extraperitoneal rupture of the bladder gives rise to extensive inflammation complicated with infiltration of urine. The so-called idiopathic inflammation is doubtless due to infection from an ulcer of the bladder or intestine, or to some similar lesion. Thus the term is of doubtful value. Such

before operation. The rapidity of growth may indicate whether the tumor is fibrous or sarcomatous.

Treatment.—The complete removal of a desmoid is the only form of treatment worth considering. Operation should be undertaken with all the precautions suitable to laparotomy. The results of treatment warrant a very favorable prognosis.

One of the difficulties of operation is control of the hemorrhage. Another is the separation of the tumor from the peritoneum, accompanied in some cases by resection of the latter. The skin-incision should be made in the long axis of the tumor and all intervening vessels should be divided between ligatures. In order to avoid a possible recurrence it is better not to dissect away from the tumor muscular and fibrous tissues which are adherent to it. Proceeding in this manner the base of the tumor is reached. The tissue to which it is attached, whether a layer of fascia or the peritoneum, must be removed with the tumor. Here again no vessels should be divided until they have been secured by clamps or ligatures. The peritoneum should be separately sutured whenever possible. If this is impossible on account of the extent of the incised portion, the omentum should be spread over the intestines and sutured to the margin of the wound. If the defect in the muscular planes and skin is too great to permit of direct suture, the wound may be closed by a plastic operation. If there is sufficient skin, it may be brought together by mattress sutures so as to form a cock's-comb and thus strengthen the scar. Such a procedure will not of itself prevent a hernia. The patient should wear a suitable bandage for a long time. The suture of the wound in layers may be supported by a few stitches which pass through the whole thickness of the wall, and any large pockets which remain should be drained. A firm bandage completes the operation. If the wound remains partially open, a tampon of iodoform gauze may be placed within it, which should be removed on the sixth day.

Epithelial Tumors of the Abdominal Wall.—Dermoid cysts and sebaceous cysts are found in the vicinity of the umbilicus. Their relation to the normal tissues is exactly the same as when they occur elsewhere in the body, and they can be readily removed under local anæsthesia.

Primary carcinoma of the abdominal wall occurs only in the vicinity of the umbilicus. Cancer of the uterus may so affect the inguinal lymphatic glands that they break down and give rise to cancerous ulcers. Cancer of the stomach or intestine may involve the abdominal wall and produce cellulitis or abscess, a cancerous ulcer, or even a fistula. The treatment of such conditions is merely palliative.

Echinococcus.—Echinococcus of the skin constitutes 2.5 per cent. and that of the muscles 1.5 per cent. of all echinococcus. It is readily understood therefore that primary echinococcus is rare in the abdominal wall. Madelung mentions 1 such instance in 196 cases. It may appear in the lumbar region, which it has reached from the duodenum, or it may appear in the preperitoneal connective tissue of the umbilicus.

The growth of the cyst is slow, and only when it reaches a considerable size does it cause pain and pressure upon the abdominal organs. It scarcely disturbs the respiration. The appetite is poor and there is loss of flesh. If the sac becomes inflamed, acute symptoms are added, with fever, redness of the overlying skin, and possibly external rupture of the contents of the cyst.

Diagnosis.—The first point in diagnosis is to exclude intra-abdominal affections, such as tumors of the kidney or liver, ovarian cysts,

FIG. 47.

Pendulous abdomen between pregnancies. (Landau.)

FIG. 48.

Pendulous abdomen in the ninth month of pregnancy. (Landau.)

and encapsulated peritoneal exudates. If the sac is inflamed, it is difficult to distinguish it from a preperitoneal suppuration. An exact history, a careful bimanual examination, and attention to the clinical signs will usually save the surgeon from mistakes in diagnosis. An exploratory incision is preferable to puncture, since if the cyst is an intra-abdominal one its contents may escape from the wound made by

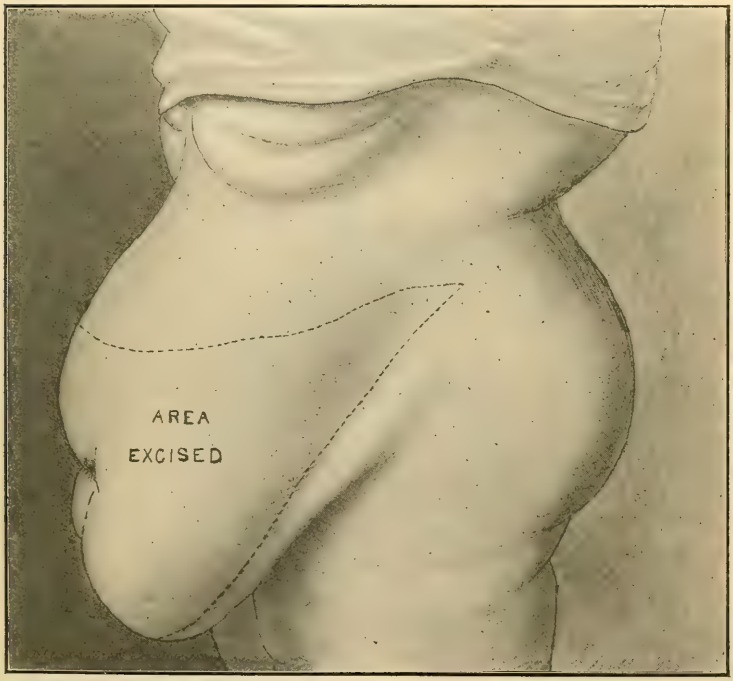
the needle and infect the abdominal cavity. If the cyst is recognized as echinococcus, it is important to know whether other portions of the body are affected. If the echinococcus of the abdominal wall has existed for a long time without symptoms referable to any other part, it is probably the only lesion.

Treatment.—The proper treatment is incision of the sac, evacuation of its contents, and a careful dissection of the inner sac from the surrounding tissues, care being taken not to open the peritoneal cavity. If such a dissection is impossible, the sac should be kept open and allowed to granulate.

OVERGROWTHS OF THE ABDOMINAL WALL.

Pendulous Abdomen.—Sometimes the abdominal wall is so stretched by repeated pregnancies that it fails to keep the abdominal

FIG. 49.



Pendulous adipose abdominal wall. The excised area is included between the dotted lines; the scars of the previous amputation of the immense pendulous breasts are shown.

organs in place, and the outline of the abdomen when the patient stands is that shown in Fig. 47. This deformity is increased during pregnancy as is shown in Fig. 48. If the overstretching of the wall is general, no relief is to be looked for from operation, but the patient can be made more comfortable by an elastic abdominal support. If

FIG. 50.

Elephantiasis of the abdominal wall. Front view.

FIG. 51.

Elephantiasis of the abdominal wall. Side view.

FIG. 52.

Elephantiasis of the abdominal wall. Front view after operation.

the wall has given way in a part only, it may be brought together and sutured according to the methods described for the cure of Ventral Hernia.

Fatty Overgrowth of Abdominal Wall.—The subcutaneous fatty tissue of the abdominal wall may so increase in amount as to become a real annoyance to the patient. Such a patient will be benefitted by the excision of a large elliptical piece of the skin and fat, weighing several pounds. (Figs. 49 and 50.)

Elephantiasis may involve the abdominal wall, as well as other portions of the body. (Figs. 50, 51, and 52.)

CHAPTER VII.

MALFORMATIONS OF THE UMBILICUS AND URACHUS.

FAULTY CLOSURE OF THE VITELLO-INTESTINAL DUCT AND ITS RESULTS.

The vitello-intestinal duct, by which the intestinal canal of the embryo communicates with the yolk-sac, and which usually disappears at about the eighth week of fœtal life, may persist and result in a number of abnormalities, such as a fistula or a diverticulum, or a cyst.

When the stump of the umbilical cord falls from an infant a few days after birth, it may expose an open vitello-intestinal duct. This duct will appear as a fine fistula secreting a few drops of mucus; or, if the duct is connected with the intestine, the secretion may possess a fecal character. Such a communication is always placed above the ileocæcal valve; and if the latter is narrow or impervious, the fecal secretion from the umbilicus will be proportionately large. The condition is then called a congenital umbilical anus.

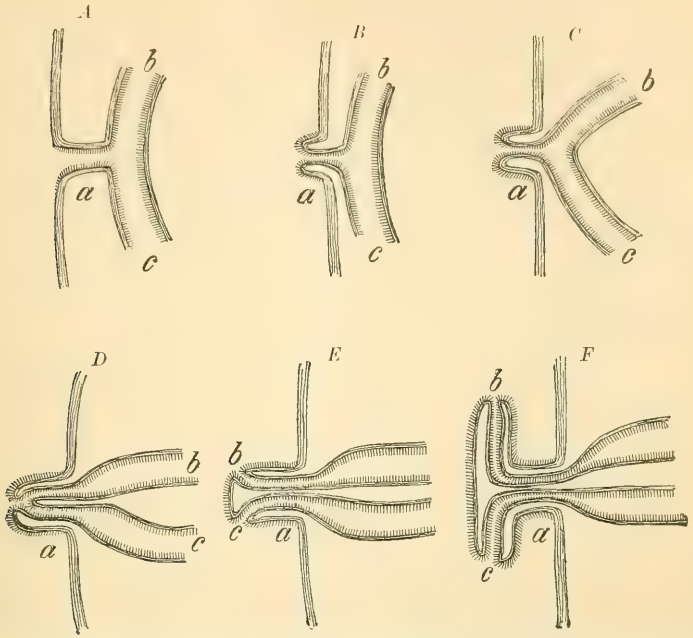
A vitello-intestinal fistula may develop some time after birth. If the duct terminates blindly at the umbilicus, its opening may be due to superficial inflammation or to the gradual accumulation of fluid which may burst outward under the influence of increased abdominal pressure (coughing, crying, etc.). Sometimes the duct extends for some distance into the umbilical cord and may be opened when the cord is severed at birth. A fistula of this character may be complicated by prolapse of the intestine, as is shown in Fig. 52.

In the most marked conditions the prolapsed intestine appears at the navel as a flat tumor with a relatively slender pedicle. The tumor is covered externally with mucous membrane, which is the lining of the vitello-intestinal duct. This mucous membrane joins with the skin of the umbilicus on one side and with the mucous membrane of the small intestine on the other. If the tumor is cut off, two intestinal openings are seen which have no connection with one another. If the intestinal contents cannot escape from the umbilicus, such an infant must necessarily die of fecal obstruction. This condition of prolapsed intestine may be associated with that of umbilical hernia.

If the vitello-intestinal duct is closed inside the abdomen but persists in the umbilical cord, after the latter falls off there will remain a tumor discharging mucus from its surface, but which shows no fistula. Such a condition has received the name of enteroteratoma, but a more natural term is prolapse of the mucous membrane of the remains of the vitello-intestinal duct.

If the duct is closed at the umbilicus, but is open within the abdomen, two conditions are possible: if it communicates with the

FIG. 53.



A, B, C, D, E, F, congenital umbilical abnormalities showing persistence of vitello-intestinal duct and the possible relations of intestine and umbilicus: *a*, abdominal wall; *b–c*, lumen of intestine. (Barth.)

FIG. 54.

Enteroteratoma measuring 2.5 by 2 cm. (1 inch), and covered with mucous membrane. The tumor was solid and contained no fistula.

intestine, a diverticulum will result; and if it is shut off from the intestine, a cyst may form. Both of these conditions are more serious than a simple external fistula, which does not communicate with the intestine.

A fistula of the vitello-intestinal duct will be recognized on inspection as soon as the cord falls off. There persists a small moist reddish tumor made up of pouting mucous membrane which gradually increases in size and discharges either mucus or mucus and feces. In the latter case a fine probe may be passed through the fistula into the intestine. If the fistula discharges mucus only, it must be differentiated from a urachal fistula and from the rare gastric fistula. The mucus discharged from the last-named fistula is of acid reaction and digests the tissues around its mouth, giving rise to an ulcer.

Radical treatment of a vitello-intestinal fistula aims to correct the abnormal attachment of the intestine to the umbilicus. The umbilical ring is divided and the little tumor is drawn forward and separated from the surrounding tissues until it can be brought out of the wound together with the attached portion of the intestine. The attachment to the intestine is then severed, the wound in the intestine sutured, the intestine replaced in the abdomen, and the peritoneum at the umbilicus sutured. The umbilical ring and the gap in the skin are also closed by sutures. If the condition is complicated by an umbilical hernia, it may be better to cut around the umbilicus to open the peritoneal cavity at one side so as to examine the parts from within, to free and close the intestine, and after removal of the umbilicus to close the abdominal cavity. An operation of this character is not a trivial one for a young child, and hence it is not usually attempted when the fistulous discharge is purely mucus or contains only faint traces of feces. Under such circumstances the fistula should be cauterized and the prolapsed mucous membrane kept back by a strip of adhesive plaster. A radical operation may be performed at a later date. If the prolapse is more marked, an operation is imperative.

A diverticulum of the vitello-intestinal duct is seen oftener in male than in female infants. It forms a small-pedicled red tumor which gradually projects more and more from the umbilicus until it reaches the size of a raspberry. It is covered with mucous membrane which passes into the normal skin at the base of the pedicle. There is no fistula connected with it. This point is of importance, since such a diverticulum has been cut off under suspicion that it was a granuloma. Such treatment will open the peritoneal cavity and possibly wound the small intestine. The distinguishing mark of a diverticulum is the mucous membrane which covers its surface. This must be entirely removed in order to prevent recurrence. The pedicle should be carefully ligated to prevent hemorrhage.

A cyst of the vitello-intestinal duct is such a rare condition that it need not be described in detail.

abscesses of unknown origin are seldom found before the thirtieth year of life. They are commoner in men than in women. They are ushered in with nausea, vomiting, and disturbed intestinal action, symptoms which are doubtless due to peritoneal irritation, and which are not usually distinguished from those due to a real peritonitis. Later, local symptoms develop, especially pain, which may be so intense that the patient avoids any exertion and lies with thighs flexed in order to relax the abdominal muscles. Soon a characteristic swelling appears, and persists even after the bladder is emptied with a catheter. The lower portion of the swelling can often be felt if the finger is passed into the vagina or rectum. If the inflammation extends to the symphysis, the bladder will become involved, as shown by disturbances in micturition. These acute symptoms are wanting in the case of a chronic abscess. Such an abscess is usually tuberculous and starts in the abdominal muscles.

Secondary Inflammation.—According to Englisch, the commonest form of prevesical inflammation is secondary, and may be due to inflammation of the pelvic bones as well as to inflammations of the pelvic organs. Tuberculosis and osteomyelitis of the bones, inflammations of the bladder and the urethra, of the prostate and of the seminal vesicles, of the uterus and broad ligaments, as well as any other suppuration in the pelvis or in the neighborhood of the appendix vermiformis, may lead to suppuration in the prevesical space. There is a severe gonorrhœal prevesical suppuration secondary to infection of the inguinal glands or to gonorrhœal cystitis. Pus which collects in the prevesical space often ruptures into the hollow organ from which the inflammation is derived. Such a rupture, or an external rupture, relieves the patient of severe symptoms, but leads to long-standing ulceration and fistulæ.

Guyon describes a collection of serous fluid in the prevesical space which he calls "hydroma prævesicale." There is a fibrous cyst-wall without epithelial lining which is dissected out with difficulty. The cause of the accumulation of fluid was unknown in most of the cases reported; in one instance it was said to be gout.

Deeply placed inflammation of the lateral portions of the abdominal wall is always secondary. Such an abscess may originate in the bones of the thorax. More frequently the pus from a perinephric abscess follows along the quadratus lumborum muscle until it appears under the skin at the outer edge of this muscle. On account of the deep situation of such an abscess fluctuation may not be evident for some time. Early symptoms are fever and pain in the region of the kidney. The kidney itself may or may not be the starting-point of the trouble.

An abscess may start from an inflammation in the appendix or in the gall-bladder, or it may be superimposed upon malignant disease of the cæcum, the acute symptoms of inflammation masking those of the tumor. An abscess of this class may result in a fecal fistula. Cancer of the stomach may give rise to inflammation and abscess formation, the pus often reaching the surface below the umbilicus.

Diagnosis.—A correct diagnosis in the acute cases of inflammation of the abdominal wall can usually be made from the symptoms of local pain and temperature elevation. It is not always easy to say whether the inflammation is primary or secondary, although this question will often be decided by the previous history of the patient. For example, if the pelvis is filled with pus, the history of the trouble is the only indication as to the starting-point of the inflammation.

Prognosis.—The prognosis of a primary suppuration is favorable if the patient is not already septic. Sometimes pus in the submuscular space breaks through into the peritoneal cavity and thus adds greatly to the gravity of the condition. The prognosis in a secondary inflammation depends entirely upon the condition of the organ in which the trouble began.

Chronic inflammation of the abdominal wall with extensive ulceration and formation of fistula is often complicated by internal suppuration. Hence the prognosis should be guarded.

Treatment.—The treatment of inflammation of the abdominal wall should be antiphlogistic until the presence of pus is manifest. Then an incision should be made, purulent cavities and fistulæ explored and split up and carefully drained. If the dressing of the wound is extremely painful, continuous irrigation may be employed, or the patient placed in a permanent bath.

ACTINOMYCOSIS OF THE ABDOMINAL WALL.

Actinomycosis of the abdominal wall comes from the intestinal canal, and is therefore usually preceded by intestinal symptoms; but the latter may be wanting. The disease of the abdominal wall often shows itself in the neighborhood of the appendix, but it may appear at the umbilicus or in the lumbar region. There is a small area of induration with indistinct edges. Soon the inflammation extends to the surface and the overlying skin breaks in one or more places and allows the escape of pus having a fecal odor and containing the characteristic organisms. Sometimes these pearly bodies are found only in the granulations. There may be a fistula which leads to the original seat of disease in the intestine.

The course of the disease is a chronic one unless it is complicated with acute suppuration. If the trouble has lasted a long time, the mouths of existing fistulæ become infiltrated and present a characteristic appearance.

Diagnosis.—The diagnosis of actinomycosis of the abdominal wall is easily made when the disease has broken through the skin; before that time the symptoms presented are similar to those of any other inflammation of this region.

Prognosis.—The prognosis of this affection is favorable if the extent of the disease in the intestine is not too great. If the appendix is the only portion of the alimentary tract affected, the outlook is

especially hopeful, since a radical operation is possible. If the actinomycosis is associated with extensive cellulitis, and especially if there is reason to suppose that the disease has affected the retroperitoneal tissues, the prognosis is far worse.

Treatment.—Treatment is purely operative. The fistula should be split and the diseased tissue removed with scissors or knife or curette. In this manner one approaches the peritoneal cavity, and if the seat of the affection is found to be the appendix, it is removed. The thermocautery is serviceable for the destruction of diseased tissue. The wound should be kept open by moist gauze compresses. The operation will often need to be repeated, but a cure is still possible even though diseased tissues have to be removed several times. The internal administration of potassium iodide is recommended, but is of doubtful efficacy.

TUMORS OF THE ABDOMINAL WALL.

Connective-tissue Tumors.—Angiomata of various sorts occur in the skin, but rarely in the deeper tissue. Fibroma molluscum appears both as a general fibromatosis of the skin and also individually as a small soft pendulous tumor that is freely movable upon the deeper structures and which is more or less attached to the skin which covers it. As the tumor grows it becomes pedicled and may reach a very large size. The pedicle often contains good-sized bloodvessels and the skin of the tumor is usually chafed and broken down. If a fibroma is growing rapidly, it should be removed on account of the danger of sarcomatous degeneration. Its removal may also be desired because of its uncommon situation. Care should be taken to ligate the vessels of the pedicle.

Sarcoma of the skin is rare. It may develop from a fibroma or from a pigmented nævus (melanosarcoma or melanocarcinoma), or it may begin as a sarcoma from apparently sound tissues. This rapid growth and the pain it causes will soon indicate its malignant character. The surface of a cutaneous sarcoma often ulcerates. The tumor quickly grows into the deeper layers of the abdominal wall. The prognosis is unfavorable, especially in the case of a pigmented sarcoma. The growth should therefore be removed early, the incision passing wide of the visibly affected tissue in order to avoid recurrence in the scar.

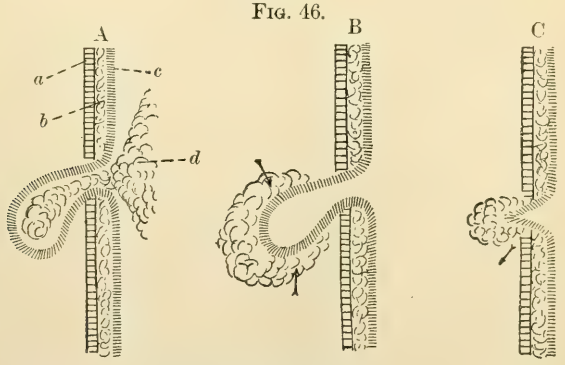
In the deeper layers of the abdominal wall are found lipomata and the so-called desmoids.

A lipoma may be subcutaneous, or intramuscular, or subserous. A subcutaneous lipoma is usually surrounded by a thin fibrous capsule which marks it off from the adjacent tissues and makes its removal easy except where it is penetrated by vessels and nerves. These tumors are found chiefly in the lateral portions of the abdominal wall. They are of slow growth and in the course of years may reach an enormous size. They may also become pedicled. If such a tumor

grows rapidly, it excites a suspicion that it is undergoing sarcomatous degeneration. As a subcutaneous lipoma is covered only by skin, its lobular structure is easily shown. This is difficult or impossible in the case of an intramuscular lipoma, a tumor which is seldom seen.

A subserous or preperitoneal lipoma is more important than the two forms already mentioned. Such a tumor is usually small, soft, and lobulated, and situated just above the umbilicus in the median line. It tends to grow through one or more gaps in the fascia and spread out beneath the skin. This growth may pull upon the peritoneum and thus produce pain, which is usually referred to the stomach. Lipoma of this character is so intimately connected with the peritoneum that it is not always possible to distinguish it from a fatty hernial sac or an omental hernia in this situation. All three have this feature in common. They reach the surface through a gap in the fascia and often produce intense pain and disturbances of digestion. If the patient is obese, it may be absolutely impossible to differentiate one condition from the other. If the little fatty tumor can be pushed back behind the fascia, the pain will often subside at once.

FIG. 46.



Schematic drawing of: *A*, omental hernia; *B*, fatty hernial sac; *C*, fatty tumor simulating hernia in the centre of which a real hernia is forming: *a*, fascia; *b*, subperitoneal fat; *c*, peritoneum.

A subcutaneous lipoma should be removed whenever its size makes it an inconvenience to the patient. This operation can easily be performed with local anæsthesia. A subserous lipoma may be held in place behind the fascia by a close-fitting bandage. If this fails, the tumor must be removed. Such an operation should be performed with all aseptic precautions, since it may be necessary to open the peritoneal cavity in order to reduce a coexisting omental hernia. The pedicle of the lipoma is followed to the fascia, and this is divided sufficiently to permit the operator to ligate the pedicle close to the peritoneum. Omentum should be ligated and removed or replaced. An existing hernial sac should be ligated and cut off and the fascia and skin sutured.

Desmoid Tumors.—By far the most interesting tumors of the

abdominal wall are those which spring from tendinous tissues, such as the aponeuroses or the transverse lines of the recti muscles, and which have received the name of desmoid tumors. A desmoid is usually a hard tumor which creaks when cut, and whose cut surface glistens in the light and shows numerous fibrous bands which cross each other at an acute angle without admixture of muscular elements. These fibres may also be arranged circularly around the vessels, in which case the tumor will have a nodular appearance. In both forms the adventitia of the bloodvessels passes without distinction into the new growth. Hence the vessels gape widely when cut and in the living subject bleed profusely. If such a tumor is softer on account of increased cellular activity, it resembles a sarcoma both in appearance and in its rapid growth. A desmoid often contains cysts with serous or mucous contents, and hence it has frequently received the names fibrosarcoma or cystosarcoma or myxosarcoma; but though different tumors of this sort present different appearances, they all originate from the tendinous structures above mentioned and simulate them in some portion of their growth. Hence it is better to include them all under the name of desmoid tumors.

These tumors are found for the most part in women. Ledderhose found that 90 such tumors occurred in women for 10 which occurred in men, and that 70 of the 90 women affected had borne children. Such a proportion suggests that either pregnancy or the stretching of the abdominal wall which accompanies it is the exciting cause of the new growth. It is noteworthy that no one of these tumors could be ascribed to stretching of the abdominal wall resulting from ascites. Other causes given are trauma and intramural hemorrhage. Whatever their cause, these tumors occur usually in women of about twenty-five or thirty years of age who have borne children or have suffered from an abdominal tumor.

The usual seat of a desmoid is near the median line, since most of them start from the tendinous structures in connection with the recti muscles. They arise less and less often, in the order indicated, from the external oblique muscles, from the transversalis fascia, and from the linea alba. They usually grow more rapidly in the direction of the fibres of the muscle from which they originate; thus the long axis of the tumor, if situated near the median line, will be up and down, while the long axis of one in the side of the abdomen will be oblique or transverse. So far as known, these tumors always grow singly.

One should not confound a desmoid with a fibromyoma of the round ligament which from its situation may grow within or without the inguinal canal.

A desmoid of the abdominal wall begins as a hard swelling which may or may not be first noticed after some traumatism. It grows slowly and causes slight or no discomfort until it reaches the size of a hen's egg. When of this size or larger, it causes a drawing or tearing pain, and tends to grow more rapidly so that in a period of from one to three years thereafter it may reach the size of a child's head.

The veins of the skin are much dilated, but the skin is otherwise normal until pressure from within or trauma produces ulceration and perhaps infection. Sometimes the growth extends over many years, being delayed by periods of quiescence or by calcification of portions of the tumor. But there is no instance of spontaneous disappearance or permanent stand-still in the growth. When the tumor reaches a certain size, it may produce symptoms of pressure upon the intestines, bladder, etc. A desmoid does not produce metastases in other organs or infection of the neighboring lymph-glands unless it has undergone sarcomatous degeneration. This complication seldom arises. In a few cases a tumor invades and destroys neighboring muscles and tendons, but it usually pushes them aside. The prognosis therefore depends not upon the malignancy of such a tumor, but solely upon its continuous growth.

Diagnosis.—A superficial desmoid may be recognized by its firm consistence and smooth surface, and by the direction of its growth, which is greatest in the line of the fibres of the muscles from which it springs. If such a tumor lies behind the muscular plane, it may easily be confounded with a hæmatoma, or the swelling which follows rupture of a muscle, or an inflammatory swelling; or, if a large tumor, it may be confounded with an intra-abdominal growth. Like all of the lesions mentioned, a desmoid is withdrawn from the palpating fingers by contraction of the abdominal muscles. If there is no history of injury and the patient is not recovering from typhoid fever, hæmatoma may be excluded. Furthermore an effusion of blood will be either absorbed or will spread, whereas a desmoid will continue to grow. It can be differentiated from a deeply placed inflammation by its lack of tenderness, by the fact that it is sharply differentiated from the surrounding tissue, and by the absence of fever, and there is almost always some known cause for an inflammatory swelling, such as disease of the bladder, intestine, bones, etc. A tumor of the liver will move with respiration, which a desmoid will not do. A tumor of the spleen has a peculiar notched border. Retroperiteneal growths, especially those springing from the kidney, are covered by rising intestine, or may be so covered if the intestine is inflated with air. A desmoid can scarcely be confounded with a tumor of the female pelvic organs unless it has reached a large size, since the only small pelvic tumor which extends beyond the pelvis is a fibroma of the round ligament. When a pelvic tumor is large, it is accessible through the vagina or rectum and its relation to the pelvic organs can easily be determined. An intestinal tumor which presses against the abdominal wall is more difficult to differentiate by palpation, but such a tumor can hardly exist without causing intestinal symptoms. A myofibroma of the round ligament lies partly or wholly within the inguinal canal. An encapsulated peritoneal exudate is a condition rarely seen and one in which the fluid may be demonstrated by aspiration. A fibroma of the abdominal wall, and a sarcoma of the omentum which has attached itself to the abdominal wall, cannot perhaps be differentiated

MALFORMATIONS OF THE URACHUS.

Another structure of the fœtal period whose relation to the umbilicus may persist and give rise to abnormal conditions is the duct by which the urinary bladder communicates with the allantois. This duct is called the urachus. In a normal child its remains are seen in the median vesico-umbilical ligament, which cord is often pervious in places. If one of these hollow portions becomes distended, a retention-cyst will be formed. Such a cyst will be situated approximately in the median line and will lie in front of the peritoneum.

An umbilical urachal fistula may be produced by the falling off of the stump of the cord in case the urachus is pervious for a certain distance. Some observers believe that the lumen of the urachus is preserved in case phimosis or some other narrowing of the urinary outlet increases the tension within the bladder. This opinion needs confirmation. The opening of a urachal fistula in the umbilical sac may be so large that a considerable portion of the bladder protrudes through it. The amount of urine discharged from the fistula will vary according to its size. The flow may be continuous or merely a few drops may appear when abdominal pressure is increased. If this fluid is clear, it will be easily recognized as urine; if it contains pus, it will be necessary to differentiate the urachal fistula from an umbilical abscess. The prognosis of an urachal fistula is favorable. A cure has often followed cauterization and continued pressure with a bandage. If the fistula is not discovered until its mucous lining has become everted, it must be freshened and sutured. Any prolapsed tissue should be cut away. It is, of course, necessary to be sure that urine flows freely through the natural channels.

Besides this congenital form of fistula there is another which develops months or even years after birth. This condition is brought about by difficult urination aided apparently by inflammation of the bladder. Such inflammation extending upward through the lumen of the urachus develops into an abscess which ruptures at the umbilicus and discharges at first pus and later pus and urine. Such a condition can scarcely be differentiated from a urinary abscess which ruptures at the umbilicus. Indeed, a positive differentiation can only be made in case urachal epithelium is found lining some portion of the wall of the abscess.

Treatment.—Treatment should accomplish three objects: 1, it must overcome any obstruction to the normal passage of urine; and 2, cure existing cystitis (for fistula of the bladder will not close while the organ is inflamed) before, 3, attempting to cure the umbilical fistula. Any operation to be successful must recognize the anatomical relations of the dilated urachus. When the two first requirements have been complied with, an incision is made around the umbilical fistula and the urachus is dissected free to its insertion in the bladder. There it is cut across and the wound in the bladder carefully sutured. The remains of the urachus are removed and the wound in the abdominal wall sutured except at its lower angle, where a small gauze drain is left.

CHAPTER VIII.

DISEASES OF THE UMBILICUS.

INFLAMMATIONS OF THE UMBILICUS.

Inflammations, Concretions, and Gangrene.—Inflammation starting at the umbilicus is almost always due to uncleanliness. Especially in stout people dust and fragments of clothing are apt to accumulate in the deep umbilical hollow. Secretion of sweat and sebaceous glands is added until the foreign matter may produce considerable irritation. As such material collects, it may gradually form itself into a solid mass, producing a so-called umbilical stone which may exist for a long time without symptoms. When as a result of traumatism secretion is increased, its exit is impeded by the stone, and swelling and redness of the parts result. The umbilical opening forms the crest of an inflammatory tumor and discharges under pressure a thick foul-smelling fluid which may easily be confounded with the contents of a broken-down sebaceous cyst. Such inflammatory conditions should be treated by the application of compresses wet with a 1 per cent. solution of aluminum acetate. When the swelling has subsided, the foreign matter can be washed from the umbilicus by a stream of water. The care of the parts consists in frequent bathing and dusting with talcum, dermatol, or some other powder. If the swelling does not diminish under the moist compresses, the umbilical ring must be divided with a knife to permit the pus and foreign material to escape. The umbilical ring can be dilated by repeated carefully applied gauze dressings so that recurrence of the trouble is unlikely.

A newborn child may suffer from various inflammations of the umbilicus, such as arteritis, phlebitis, simple suppurative inflammation, or erysipelas. The prognosis under such circumstances is unfavorable. The treatment consists in suitable surgical dressing. Sometimes the umbilicus of an emaciated child becomes gangrenous. Weak antiseptic dressings and strengthening diet are necessary. There is great risk under such circumstances that the process will extend to the abdominal cavity.

Inflammatory Umbilical Fistula.—The umbilicus is the thinnest part of the abdominal wall, hence it is a favorite seat for the escape of pus from an intra-abdominal abscess. This may occur in the acute form after the existence for a longer or a shorter time of intense pain, swelling, and redness. The process may also assume a chronic form. In either case, when rupture has taken place there will be a discharge from the fistula of pus mixed with feces, urine, bile, etc.,

according to the origin of the abscess. Such a fistula receives accordingly different names.

A fecal fistula may be due to a variety of causes. An umbilical hernia may become gangrenous, or a foreign body in the intestine may work its way outward. There may be tuberculous or gangrenous ulcers of the stomach or intestine, or a simple gastric ulcer may perforate, or a fistula at the appendix may lead to a fistula at the umbilicus. In rare cases tuberculous peritonitis will produce an umbilical fecal fistula. Round worms may make their escape through an umbilical fecal fistula, but that they are capable of producing such a fistula is not generally believed.

A urinary fistula at the umbilicus may be due to extraperitoneal rupture of the bladder either traumatic or due to inflammation. An umbilical fistula may follow rupture of a suppurating echinococcus cyst, or a suppurating gall-bladder may discharge itself through the umbilicus.

A peritoneal fistula without inflammation of any abdominal organ may be produced by an ascites of marked degree or by acute or chronic suppurative peritonitis. Cystic tumors of the ovary may exceptionally rupture through the umbilicus.

The nature of an umbilical fistula which discharges feces or small gall-stones or urine will soon be evident. When such a fistula discharges only mucus or mucus mixed with pus, and admits a probe for only a short distance, and when the history of the illness throws no light upon the region of the trouble, the cause of the fistula may be in doubt. Certain articles of food—for example, huckleberries—may serve to confirm a diagnosis of fecal fistula. Irrigation of the bladder with a colored fluid will show whether its contents escape at the umbilicus. A careful microscopical examination of the secretion will sometimes be of service, but in some cases the origin of the trouble must remain in doubt.

The prognosis of such a fistula depends upon the general condition of the patient and the source of the trouble. If the fistula is due to tuberculous peritonitis, the prognosis is naturally an unfavorable one. On the other hand, the formation of a fistula in ascites or in acute or chronic suppurative peritonitis may lead to a spontaneous cure. A fistula connecting with the gall-bladder will not permanently close until all gall-stones have passed and the suppurative discharge gives place to one of pure bile. An extensive operation is necessary to cure a patient of a permanent biliary or fecal or urinary fistula.

TUMORS OF THE UMBILICUS.

Pernice divides tumors of the umbilicus into three classes: inflammatory tumors, connective-tissue tumors, and epithelial tumors.

Inflammatory Umbilical Tumors.—The granuloma of early infancy and the papillary fibroma of later life belong in this class. A granuloma is sometimes called an umbilical fungus. It develops after

the umbilical cord falls off as a result of inflammation in the wound, usually due to uncleanliness. The raw surface granulates and grows outward until a small-pedicled tumor is formed. If such an umbilicus is examined three or four weeks after the wound should have healed, there will be found in the bottom of the umbilical hollow a small mass of granulations whose surface is covered with a purulent secretion. This will serve to distinguish it from an enteroteratoma, which is covered with mucous membrane, while the absence of an opening distinguishes it from a vitello-intestinal fistula. In rare cases the granuloma becomes covered with a layer of thin epithelial cells and the resulting pedunculated tumor will then remain indefinitely without symptoms in the bottom of the umbilical hollow.

The first principle of treatment is a painstaking cleanliness in order to induce cicatrization of the umbilical wound. If this does not succeed, the granulations should be touched with a stick of silver nitrate, or, if necessary, the tumor may be snipped off with scissors before the caustic is applied. One should be certain that it is composed wholly of granulation-tissue before removing it.

A papillary fibroma is due to chronic irritation of the umbilicus. It is a firmly pedicled tumor which may reach the size of a nut and is made up of branching papillæ. Such a tumor may undergo cancerous degeneration when it occurs in this part of the body, as well as elsewhere. If it does so, it becomes fixed in the umbilical hollow. There are also papillomata which are sessile, and which if they ulcerate can scarcely be distinguished from cancer except by microscopical examination.

As a papillary fibroma is a benign tumor, it is safe to destroy it by chromic acid or other caustics. If it is too large for this treatment, it should be removed with a knife or curette. If there is suggestion of cancerous degeneration, extirpation should be thoroughly carried out even if the peritoneal cavity is opened in the process.

The umbilicus may be the seat of a gumma which simulates a malignant growth.

Connective-tissue Tumors.—Fibroma, fibrolipoma, angioma, and myxoma of the umbilical region are among the rarest of tumors. Sarcoma occurs more frequently, usually in the form of fibrosarcoma. Such a tumor is firm and has no pedicle. It is covered with normal skin until it ulcerates as a result of mechanical irritation. The veins in the skin are much dilated. It grows slowly and does not infect the neighboring lymph-glands. These tumors occur usually between the thirteenth and fifty-fifth years of age. They are generally found in women, and are therefore supposed to be, like the desmoid tumors, indirectly the result of traumatism due to pregnancy. Such a tumor can be readily removed, although it may be necessary to take with it a portion of the peritoneum. The prognosis is favorable. The other connective-tissue tumors are soft, and are therefore easily distinguished from sarcoma. When thoroughly removed, recurrence is unlikely.

Congenital myxosarcoma of a telangiectatic type may develop in

the portion of the umbilical cord which remains. Such a tumor may be successfully removed soon after birth.

Epithelial Tumors.— Dermoids and sebaceous cysts are found in the umbilical region and may reach a considerable size. The peritoneal cavity may be opened in their removal. This does not add greatly to the risk if the operation is an aseptic one. If such a cyst is suppurating, its contents should be evacuated and its cavity stuffed with iodoform gauze before the peritoneal cavity is opened. These benign tumors are of far less significance than carcinoma of the umbilicus.

An umbilical carcinoma may be primary or secondary to disease of some abdominal organ, especially the stomach and intestine. Secondary carcinoma is much more common than the primary variety.

A primary carcinoma usually springs from the superficial epithelium of the umbilicus, and is therefore an epithelioma. From the beginning, it forms a shallow ulcer with foul-smelling secretion and crusts. Such a growth is apparently due to chronic inflammation the result of uncleanliness. The papillary carcinoma appears as a cauliflower-like mass with a broad pedicle and firm infiltrated base. Such a tumor is said by Hübner to spring from a papilloma which is subjected to constant irritation. Both of these forms of primary cancer grow slowly. There is also a scirrhous carcinoma of the umbilicus which starts from the superficial epithelium and grows rapidly. It does not ulcerate until a later period and produces metastases in the mesentery as well as in the lymphatic glands, whereas the two other forms mentioned produce metastases in the lymphatic glands only. Tubular and colloid forms of cancer have been described by Pernice and others, but they are very rare. The diagnosis of a carcinoma is not difficult, since it presents the characteristic appearance of hard ulcerating base and raised edges. In very stout persons it may be difficult to bring the hidden ulcer into view. A microscopical examination may be necessary to decide whether a papillomatous tumor is malignant or is the seat of a simple inflammation.

The prognosis in case of epithelioma and papillomatous carcinoma is favorable if the tumor is removed at an early stage. It is not so good in scirrhous, and far worse in the rare tubular and colloid forms of cancer.

Secondary carcinoma of the umbilicus is due in two-thirds of the cases in which it occurs to disease of the alimentary tract or the liver, and in one-third of the cases to disease of the female genital organs. The primary disease extends by continuity to the umbilicus in the large majority of cases, being due to metastasis only 5 times in 29 cases, according to Pernice. The form of a secondary cancer is the same as that of the primary tumor; hence if microscopical examination of an umbilical cancer shows that the growth is of a cylindrical type, it is safe to assume that it is secondary to disease of some abdominal organ. Under such circumstances operation is naturally useless unless intense pain or hemorrhage makes a partial removal or curettage advisable. Such treatment will rarely be called for, however, as the appearance of carcinoma at the umbilicus is a late manifestation of the disease.

INJURIES AND DISEASES OF THE PERITONEUM—LAPAROTOMY.

By Prof. KÖRTE.

General Considerations.—The injuries and diseases of the peritoneum are intimately associated with those of the abdominal and pelvic organs. Primary affections of the peritoneum are less common than those of the organs which it covers; but nevertheless they may be of great importance. Moreover, when disease of an abdominal organ reaches its peritoneal covering and there produces inflammation or new growth the effect upon the patient may be very great indeed, for from that time the disease affects not merely a single organ, but the most extensive serous surface of the body.

Three factors are worthy of especial notice in connection with peritoneal lesions: namely, the great extent of the peritoneum and the rapidity with which an inflammation can spread over a large part of its surface; second, the great capacity of this membrane for absorption, which may be of immense benefit to the system, or which may be of very great injury; and, third, the capability of the peritoneum when irritated to form a very large exudate. This exudate may be of a fibrinous character and result in adherence of the serous surfaces; or it may be of a fluid nature, rich in albumin, easily changed in character; or it may be seropurulent.

Anatomical Considerations.—The immense serous cavity of the peritoneum is a closed sac in man, while in woman it communicates with the outer world through the Fallopian tubes, uterus, and vagina. Diseases of these organs may therefore extend to and involve the peritoneum. The peritoneum lines the walls of the abdominal cavity and covers the various abdominal organs with a tissue which is in most places loose and movable, but which in certain places is firm and closely adherent to the underlying structures. Some abdominal organs are more or less firmly fixed by duplicatures of the peritoneum (liver, spleen, and female pelvic organs). Some portions of the intestine, such as the duodenum, ascending and descending colon, are only partially covered with peritoneum, while the rest of the small intestine, the transverse colon, and the sigmoid colon are attached by a duplicature. The duplicature or mesentery of the small intestine is indicated by a line extending from the left side of the second lumbar vertebra obliquely to the right iliac fossa. The transverse colon makes an arch

convex downward. The sigmoid colon on account of its long mesocolon is quite movable, but is usually situated in the left lower quadrant of the abdomen.

The motility of the greater portion of the intestinal canal facilitates a rapid spread of inflammatory processes over its serous surface. The numerous folds and pouches of the serous membrane, due to its being spread over the abdominal organs, makes its outline very complicated. For the same reason it is difficult to inspect the whole of the peritoneum, or to cleanse it, or to wash out its cavity. These duplicatures and pockets also make it possible for inflammatory products to become encapsulated more readily than is the case in simpler serous sacs. Some of these serous lined spaces and pouches are named. The subphrenic space, which is situated just beneath the diaphragm, is divided into a right and a left portion by the suspensory ligament of the liver. The liver forms the lower boundary of the right portion of the space, and together with the stomach and spleen the lower boundary of the left portion. The pancreas lies behind the stomach, rising slightly above the lesser curvature, and is covered by the posterior layer of the peritoneum. The stomach twists during the period of development, rotating upward and to the right, so that what was at first the left side of the stomach becomes its front, and the right side becomes its back. As a result of this rotation of the stomach a serous cavity is formed behind it, called the lesser peritoneal cavity or omental bursa, which communicates with the greater peritoneal cavity through the foramen of Winslow. The omentum is attached to the transverse colon, and the transverse colon is attached to the posterior abdominal wall by the transverse mesocolon. These structures therefore form a sort of transverse partition which separates the upper part of the abdomen from the lower part, and which in case of inflammation often becomes with the help of adhesions a real partition which is able to confine the inflammation to one portion of the peritoneal cavity. In a similar manner the mesentery and the small intestine divide the abdominal cavity into a right and a left portion.

The peritoneum covers the upper and posterior surfaces of the bladder, passing in men from the lower portion of the bladder to the rectum (Douglas's pouch). In women it covers the uterus, tubes, and ovaries, before reaching the rectum, so that between the uterus and bladder there is a vesico-uterine pouch, and between the uterus and rectum a recto-uterine pouch or the pouch of Douglas.

The whole area of the peritoneum is approximately equal to that of the skin.

For convenience the abdomen is divided into the following regions: The *epigastric*, situated in the median line and extending from the ensiform process to the umbilicus, contains the left lobe of the liver, the stomach, the pancreas, and the median portion of the transverse colon. In the *right hypochondriac* region are situated a portion of the liver, the gall-bladder, the right colic or hepatic flexure, and the right

kidney. In the *left hypochondriac* region are situated a portion of the gastric fundus, the spleen, the tail of the pancreas, the left colic or splenic flexure, and the left kidney. The *central* portion of the abdomen, below the umbilicus, contains the coils of small intestine. In the *right iliac* fossa are situated the cæcum with the appendix and the ascending colon, while in the *left iliac* fossa are to be found some coils of small intestine and the sigmoid colon. The bladder and the female pelvic organs are situated in the *pelvic* region; the rectum lies behind them in the hollow of the sacrum. Coils of small intestine often lie just in front of the rectum.

The peritoneum is a connective-tissue structure of great elasticity whose parietal layer is attached to the abdominal wall by loose cellular tissue containing much fat. It is easily stripped off by blunt dissection. Wherever the abdominal wall is naturally weak, or is weakened by disease, the peritoneum may be pushed outward, thus forming an abnormal pouch called a hernia.

The free surface of the peritoneum is covered with a single layer of endothelial cells between which, at least in the region of the diaphragm, are openings which are in direct communication with the lymphatic system. The healthy peritoneum has a shiny, smooth surface which is lubricated with a minimum amount of fluid so that opposing surfaces readily slip one upon the other.

There are few bloodvessels or lymph-vessels in the peritoneum. What nerves there are spring from the sympathetic system and from the phrenic and vagus nerves. In its normal condition the peritoneum is not very sensitive, but it becomes extremely so when inflamed. Lennander says that the parietal peritoneum contains a great number of sensitive nerves, while the vesical peritoneum covering the stomach, intestine, mesentery, and gall-bladder, possesses no nerves which are capable of giving sensations of pain, touch, heat or cold. This statement has been verified by many surgeons who have opened the abdomen under local anæsthesia.

Physiological Pouches.—There are certain peritoneal pouches in which the intestinal coils may become strangulated. The most important are:

1. The foramen of Winslow is the opening between the larger and lesser peritoneal cavities, which owes its origin to the rotation of the stomach which takes place early in fœtal life.

2. Waldeyer calls attention to a pocket which exists between the liver, duodenum, and upper end of the right kidney in case the renal ligament is unusually developed.

3. The intersigmoid pouch is situated in the line of attachment of the left layer of the sigmoid mesocolon. This pouch has been ascribed by some observers to the folds produced by bloodvessels, and by others to the effect of fœtal development.

4. There are three pericæcal pouches, the anterior ileocæcal, the ileo-appendicular, and the posterior ileocæcal. The last-named pouch varies greatly in different individuals, since it depends upon the fœtal

fusion of the cæcum and colon, and the development of the parietal peritoneum.

5. The left duodenojejunal pouch is dependent on the development and course of the inferior mesenteric vein. Broesicke calls attention to several folds in the duodenojejunal flexure which are the result of fœtal fusion.

There are other less well-marked pouches which may be produced by vascular folds of the anterior abdominal wall, or of the iliac fossæ, or of the retrovesical space.

Transudation and Resorption.—It has been shown that the diaphragmatic portion of the peritoneum contains little openings which connect with the lymphatic system, and through which fat-drops and fine grains of powder as well as fluids may reach the thoracic duct and by it the general circulation. It is not known whether other portions of the peritoneum possess similar lymphatic openings. The absorptive power of the peritoneum for fluids is so great that an animal will take up from 3 to 8 per cent. of his body weight in an hour, while poisonous substances injected into the peritoneal cavity will act more quickly than when they are inserted into the intestinal canal. It has also been shown that while an increase of the normal peristalsis does not hasten this absorption, that a decrease of peristalsis will markedly delay it. Bacterial inflammation and chronic inflammation due to mechanical injury will also delay absorption. This peritoneal absorption is not a purely physical process, but rather a vital physiological one.

The peritoneum has also a great power of transudation. If a concentrated solution of sugar or glycerin is injected into the peritoneal cavity of an animal, the peritoneum is capable of diluting it by transudation equivalent in an hour to 4 or even 8 per cent. of the body weight. Under other circumstances the peritoneum is capable of producing a plastic cystic exudate in a very short time. Foreign bodies which are aseptic are quickly enclosed by a fibrinous exudate and by cells derived from the subserous tissue. Fibroblasts press into this exudate and lead to the formation of bloodvessels and connective tissue, so that the foreign body becomes completely surrounded by new connective tissue. If the foreign body which is thus encapsulated is capable of disintegration, it will ultimately be resorbed.

The peritoneum possesses many properties favorable to surgical operations. It can take up great quantities of fluid. Up to a certain point it can take up and render harmless bacteria. Extensive injuries of the serous coat, whether brought about by mechanical, thermal, or chemical agents, can be healed so that no permanent defect remains. A considerable quantity of ligated tissue, stumps of ligatures, and foreign substances may remain in the peritoneal cavity and become encapsulated without disadvantage. The recuperative power of the peritoneum is far greater than that of other soft tissues of the body. However, its power for protection in these various directions is limited to conditions in which the pathogenic bacteria present are not too

numerous nor too virulent. When this limit of safety is passed, the peculiar properties of the peritoneum greatly increase the danger. Peritoneal exudates form an excellent culture-medium in which bacteria can increase in a short time with great rapidity. Furthermore, the power of resorption of a serous membrane may load the blood with pathogenic bacteria and their toxins, so that the vitality of the body-cells is destroyed.

CHAPTER IX.

INJURIES OF THE PERITONEUM.

The peritoneum bears injuries well provided the wound does not become infected. Rents due to overstretching of its tissue, contusions, burns by heat and caustics, are quickly recovered from, provided no pathogenic bacteria find their way into the peritoneal cavity. They may enter it from outside through the wound, or more frequently from some internal organ that has been injured. Pus-producing cocci are the most dangerous invaders. Saprophytic bacteria are more easily overcome by the living tissues.

Traumatic rupture of intra-abdominal organs, like an ulcerative perforation, in the great majority of cases produces infectious peritonitis. In traumatic perforation the patient has these advantages: the ruptured organ is usually healthy, and the perforation is more or less closed by muscular contraction. In rare instances it happens that this muscular contraction is sufficient to prevent escape of infectious material into the peritoneal cavity. Injury of an abdominal organ carries it with a second danger, that of intra-abdominal hemorrhage. The bloody-supply of the abdominal organs is abundant, the vessels are poorly protected by thin membranes, and if they are torn an alarming hemorrhage takes place in a short time.

OPEN WOUNDS OF THE ABDOMEN.

The most important question in connection with abdominal wounds is the possible injury of some abdominal organ. A penetrating wound of the abdomen may exist without such complication, but this is the exception, especially in gunshot-wounds. If the penetrating wound is made with a blunt object, the abdominal organ which lies in its way may be pushed aside without injury. Penetrating wounds of the epigastrium are less regularly accompanied by injury of some abdominal organ than those of the lower portion of the abdomen.

Internal hemorrhage is marked by progressive anæmia, a small quick pulse, weakness, and cold perspiration. Frequently there are also symptoms referable to irritation of the peritoneum. It is often difficult to say whether the abdominal organs have escaped injury, since the signs of peritonitis may not manifest themselves for some hours. Senn's proposal to inject hydrogen gas into the rectum in order to reveal the presence of intestinal perforation is an unwise procedure, since it may result in forcing the intestinal contents into the peritoneal cavity. Tension of the abdominal muscles, continuous ab-

dominal pain, nausea, and the passage of hemorrhagic material from the mouth or from the rectum are early signs of serious intra-abdominal injury. If one waits for more positive evidence, he will miss the most favorable opportunity for the operative repair of the injury.

Two lines of treatment are possible. The advice given by Reclus, Stimson, and others is to wait in the hope that penetrating wounds of the intestine may heal spontaneously. While this possibility is not disputed, it is of rare occurrence, and to most surgeons it seems unsafe to trust to such a fortunate result, especially as more than one wound may exist.

Statistics published by Postemski in 1891 showed that from 60 to 70 per cent. of 645 cases of penetrating wounds of the abdomen treated in the ten years previously terminated fatally, while the mortality of penetrating wounds complicated by injury of some abdominal organ was 100 per cent. There were 36 patients with uncomplicated wounds operated upon, all of whom recovered; and 22 patients with penetrating wounds complicated with intra-abdominal injury, of whom 12 recovered. Lühe collected 322 cases of penetrating abdominal wounds of all sorts treated by operation, the mortality of which was 49.4 per cent.

In view of the great risk due to possible injury of some intra-abdominal organ and intra-abdominal hemorrhage it seems advisable to explore as soon as possible every penetrating wound of the abdomen in which the nature of the injury or the early symptoms point to the possibility of internal damage. This should certainly be the rule when the conditions are such that an operation of this magnitude can be aseptically carried out. If this treatment is followed, it will doubtless happen that the abdomen is sometimes opened although no serious intra-abdominal injury exists. This will not, however, add greatly to the risk if the operation is properly performed, and this rule of operating early in all suspicious cases will save many patients from peritonitis and intra-abdominal hemorrhage.

The incision should usually be made through the wound. If the peritoneal cavity contains blood, the ruptured vessel should be sought for and ligated either directly, or in the case of the liver or spleen by passing a ligature through the tissue around the vessel. If the hemorrhage cannot be checked in this way, the wound in the organ should be tamponed.

In examining an intestine it should be remembered that bullets especially are apt to wound the intestine in several places, each one of which must be carefully sutured after resection of any badly injured tissue. The peritoneal cavity should be cleansed with hot saline solution and gauze in the manner hereafter described, and the wound in the abdominal wall sutured exactly. If tamponade is necessary, a portion of the wound is left unsutured to permit withdrawal of the gauze.

Subcutaneous Injury of the Abdomen.—A blow or bruise of the abdomen may injure the organs within while the elastic abdominal wall

escapes. This is especially true of such solid organs as the liver, spleen, and kidneys, which may suffer partial or complete rupture. A fall from a height may produce a similar injury. The stomach, urinary bladder, or gall-bladder, if distended with fluid, may be ruptured by a blow or a fall. The intestine usually escapes without injury unless the force is so directed as to press the intestine against the spinal column or the pelvic brim. Under such circumstances a portion of intestine may be torn off from its mesentery. Such an injury is followed by gangrene of the affected portion. On account of the deep situation of the pancreas it usually escapes injury, but in a few cases it has been torn across by pressure directed backward against the spinal column.

The serious effects of spontaneous injury are hemorrhage and rupture of a hollow organ, with discharge of infectious material into the peritoneal cavity. Sometimes a severe shock follows the injury. If the shock is due to hemorrhage and not to the injury itself, it will not decrease as time goes on, but will rather increase, and the patient will further exhibit the symptoms of increasing anæmia, a pulse growing weaker and faster, exhaustion, and restlessness. The effects of rupture of an intestinal organ are usually seen within six, or at the latest twelve, hours after the injury, the symptoms being intense abdominal pain, rigidity of the abdomen, nausea, hiccough, and vomiting. A few hours later the abdomen becomes distended and other symptoms of peritonitis develop. If the intestine is not torn, but is separated from its mesentery, or if necrosis follows a bruise of the intestinal wall, the immediate symptoms of shock may pass over and the patient be comparatively comfortable for a time until necrosis of the intestinal wall leads to peritonitis. Under such circumstances adhesions may form about the injured part, so that after perforation takes place intestinal contents are discharged not into the general peritoneal cavity, but into a walled-off space.

It is even more difficult to decide upon the necessity for operative treatment in case of subcutaneous abdominal injury than when there is an open abdominal wound. Shock is to be abated by a dorsal position of the patient and external heat, and if necessary subcutaneous injection of stimulants. If the general condition does not improve and the injuries of other portions of the body will not explain the lack of improvement, it must be assumed that there is intra-abdominal injury.

The diagnosis of internal hemorrhage is usually not difficult to make; but it is impossible to say from what organ the blood comes unless it is revealed by the character of the injury. The object of a laparotomy under such circumstances is to control the hemorrhage and repair the abdominal injury provided the general condition of the patient warrants such a step. The incision should be in the median line. Blood-clots should be sponged out and torn vessels ligated. Wounds of the liver may be closed by deep sutures or drained with iodoform gauze. A badly torn spleen should be removed. Irrigation with hot saline solution will not only cleanse the peritoneal cavity, but will also act as a stimulant to the patient.

It is not so easy to determine the presence of intra-abdominal injury which is likely to give rise to peritonitis. The following symptoms are present under such circumstances: repeated or continuous vomiting of bilious or bloody material, extreme contraction of the abdominal muscles, especially of the recti muscles, paralysis of the intestine, a part of which is contracted and a part dilated. If such symptoms are present after a severe contusion, the abdomen should be opened if the operation can be properly performed. Even the practised surgeon will sometimes be in doubt as to the existence of intra-abdominal injury since the first period of shock is frequently followed by a period of comparative ease. In such cases it is necessary to wait, keeping the patient under close observation until renewed exudation or vomiting, contraction of the abdominal muscles, slowly increasing distention, and rise of the pulse make it advisable to operate. If one waits until the symptoms of peritonitis are well established, the most favorable time for operation has gone by. It is therefore advisable to withhold morphine and similar drugs from such a patient lest they benumb his consciousness and mask the symptoms of his condition. It should be remembered that a gradually increasing retroperitoneal hemorrhage, such as occurs with fracture of the spine or pelvis, may bring about a general increasing intestinal paralysis likely to be confounded with injury of the intestine.

If one follows the principle of early operation in these cases, he will sometimes needlessly open the abdomen. The risk thus caused is far less on the whole than the danger of postponing operation in case the intestine is ruptured. For the technic of operations upon the different abdominal organs the reader is referred to subsequent sections of this volume.

A late result of severe abdominal contusion is the formation of adhesions between serous surfaces which may cause the patient great pain and lead to stenosis of the intestine. Fecal abscesses may form in the vicinity of a bruise of the intestinal wall which will require opening or other treatment.

The discharge of aseptic bile as a result of rupture of the liver or biliary vessels brings about an aseptic chronic peritonitis with the formation of abundant bile-stained exudate, which should be drawn off by puncture or incision if it is not resorbed spontaneously in a short time.

Normal urine irritates the peritoneum, but is not capable of setting up an infectious peritonitis. It is easy, however, for germs to make their way through the ruptured bladder into the peritoneal cavity, usually as the result of catheterization. Hence it is better to operate as soon as the diagnosis of rupture of the bladder is made.

A moderate-size hemorrhage may become encapsulated, forming an intraperitoneal blood-cyst. Cure of this condition will sometimes follow simple puncture. At other times it is necessary to incise the cyst and drain it for a time. Such a collection of blood is occasionally seen in the neighborhood of the pancreas, or in the omentum or mesentery, or in the neighborhood of the spleen.

CHAPTER X.

DISEASES OF THE PERITONEUM.

INFLAMMATIONS OF THE PERITONEUM.

Inflammations of the peritoneum are the most important lesions which can affect it, and which, on account of its great extent and capacity for absorption, are dangerous to the life of the individual. The various inflammations may be classified according to their pathological appearances, as fibrinous, serous, suppurative, and gangrenous peritonitis; or they may be classified according to their origin, as infectious and non-infectious or idiopathic peritonitis. They may also be separated into acute and chronic, circumscribed and diffuse, or general peritonitis. This last distinction, according to the extent of the inflammation, is of practical importance with reference to prognosis and treatment, for a patient suffering from a well-defined limited peritonitis is in quite another condition from one who is suffering from an inflammation already involving a considerable part of the peritoneum and rapidly extending further. In the first case the local symptoms are prominent, while in the second they are quite obscured by the severer general symptoms. The term general peritonitis or diffuse peritonitis is somewhat misleading. Repeated post-mortem examinations have shown that certain portions of the abdominal cavity are usually protected by adhesions from even a widespread peritonitis. Hence it is better to discard the term general peritonitis, and to use instead the term diffuse or extending peritonitis, meaning thereby that the inflammation has already affected a considerable portion of the peritoneal cavity and has a tendency to spread still further. Just how far inflammation has spread in any particular case it is not easy to determine. Mikulicz recognizes three forms of diffuse peritonitis: a diffuse septic peritonitis, a gangrenous peritonitis, and a progressive fibrinopurulent peritonitis.

In most cases of peritonitis inflammation extends to the peritoneum from some adjacent organ. A primary idiopathic peritonitis in the strict sense is of the rarest occurrence; indeed, a careful examination of the autopsy records of the cases which formerly were diagnosticated as acute primary will oftentimes show the starting-point of the inflammation to have been in the disease of some abdominal organ.

Many writers still retain the term idiopathic as applied to cases of chronic peritonitis in which no starting-point for the inflammation can be found in disease of any abdominal organ, but even here the term should be used with the distinct understanding that failure to find a

starting-point for the inflammation outside of the peritoneum does not prove that the trouble actually started in the peritoneum itself.

Diffuse Peritonitis.—**Pathological Anatomy.**—The pathological appearances of acute peritonitis vary in different patients, and even in the same patient, so that one portion of the abdominal cavity may differ from another. Inflammation of the serous membrane manifests itself by injection of the vessels and a fibrinous exudate upon its surface. The shiny appearance of the membrane is lost, and instead it looks cloudy and rough. If a migration of leucocytes is added, the fibrinous exudate takes on a purulent character. If the inflammation is of a mild degree, the tissue-cells of the serosa are stimulated to growth, and there will result a new formation of bloodvessels, adhesions and thickening of the peritoneum. In some cases, both mild and severe, the fibrinous exudate may so stick together opposing surfaces as completely to shut in the inflamed area. In other cases the process spreads through the fibrinous exudate and involves extensive areas of the peritoneal surface. The subserous tissue becomes strongly œdematous, and therefore the intestinal walls, the omentum, mesentery, etc., appear swollen.

The fibrinous exudate is usually accompanied by a serous exudate which remains clear if the inflammation is an aseptic one, but is clouded by migrated leucocytes as soon as bacteria begin to grow in it. The serous exudate may be stained by an admixture of blood. If the intestinal bacteria and other bacteria are added to the exudate, it will undergo putrefaction, possibly even to the extent that putrefactive gases are formed. Suppurative inflammation of the peritoneum may involve in a short time the greater portion of the membrane. In other cases it advances step by step, being more or less limited by adhesions. In this manner the process may be stopped altogether and take on a chronic form (abdominal empyema). Sometimes the inflammation in different portions of the abdomen will take on a different character. Thus one pouch may contain pus and another one more or less serum, being separated by fibrinous adhesions.

Etiology.—Peritonitis may be infectious—that is, produced by the influence of pathogenic bacteria and other toxins; or it may be aseptic, brought about by mechanical or chemical lesions. The first type is more frequent and far more dangerous. It is usually due to one of the following named kinds of bacteria: streptococcus and staphylococcus, bacterium coli, and, more rarely, gonococcus, pneumococcus, and others. The infection is usually a mixed one—that is, due to more than one bacterial species.

Wegner, Grawitz, and others have shown that a healthy peritoneum can endure without injury a certain quantity of fluid containing pathogenic organisms. If the surface-cells of the peritoneum are injured and its power of absorption is thereby limited, the same quantities of bacterial fluid will set up suppurative peritonitis. Mechanical and chemical injuries, the presence of a great quantity of toxins or of foreign bodies, such as fecal matter or blood-clots, enable the pathogenic

bacteria to multiply in spite of the protecting action of the peritoneum. These principles have been established by experiments upon animals and are strictly in accord with clinical observations upon man. For example, the results of abdominal operations are far better than they were at the time when operators used strong antiseptic solutions in the abdominal cavity, and were not so careful as they are now to avoid the mechanical irritation of sponging, etc.

Experience has shown that chronic inflammation of the peritoneum, such as occurs about the female pelvic organs and in the neighborhood of the cæcum, reduces the resorbtive capability of the peritoneum.

Infected organisms may enter the abdominal cavity in a variety of ways. They may be introduced through a wound. In women they may pass through the open ends of the Fallopian tubes. They may reach the peritoneal cavity or any organ which is covered with peritoneum. The intestine always contains a great number of bacteria, ferments, and toxins, which in disease may extend to the liver, spleen, and pancreas. Traumatism or an ulcerative process may be the means of transplanting these bacteria into the abdominal cavity, or the bacteria themselves may pass through the diseased intestinal wall without actual perforation. This is impossible as long as the intestinal wall is healthy. These principles hold true not only for the intestinal wall, but also for the walls of the gall-bladder and the Fallopian tubes. Whether ferments and toxins can also pass through the diseased or necrotic intestinal wall has not been determined. Neither is it known whether microbes which are circulating in the blood can set up an infectious peritonitis without previous disease of the intestine.

Infectious peritonitis is usually of a purulo-gangrenous character. If the disease exists in a very acute form, to which Wegner gives the name peritoneal sepsis, death may occur very early on account of overloading of the blood with septic material. Under such circumstances the serosa shows only a slight injection, while its surface is clouded by a delicate deposition of fibrin and the peritoneal cavity contains only a small amount of cloudy or hemorrhagic exudate in which there are great numbers of bacteria.

Aseptic Peritonitis.—Chemical or mechanical irritation may produce an aseptic peritonitis of the fibrinous, serous, or hemorrhagic type. Such inflammation tends to heal with the formation of adhesions, and only becomes suppurative in case pathogenic organisms enter the peritoneal cavity.

A good illustration of chemical peritonitis is that produced by the rupture of an aseptic ovarian, echinococcus, or other cyst, or by the discharge of aseptic bile or urine into the peritoneal cavity. Strong antiseptics, such as solutions of carbolic acid or mercuric chloride, and irritants, such as croton oil, turpentine, or tincture of iodine, will also inflame the peritoneum. A discharge of blood into the peritoneal cavity acts as an irritant just as it does in the cavity of a joint, and sets up an aseptic inflammation resulting in adhesions. Repeated injections of air and the introduction of aseptic foreign bodies set up

a fibrinous peritonitis in animals, while the presence of ligatures, cauterized areas, etc., give rise to a chronic adhesive peritonitis in man.

An aseptic peritonitis may also be caused by a contusion of the serosa without other injury; also by chronic obstruction of the circulation, as caused by twisting the pedicle of a tumor, or twisting or other obstruction of an intestinal loop, provided that the injury does not make the intestinal wall pervious to the bacteria within the intestine. Under such circumstances the serosa is reddened and covered with a layer of fibrin, and the peritoneal cavity contains serous or serohemorrhagic fluid without bacteria. The tendency of the disease is toward recovery as long as bacteria are absent. If they are introduced, they find in the exudate a most favorable soil for their rapid development.

Sources of Peritoneal Infection.—Any organ which is partially covered by peritoneum may give rise to peritonitis, but the two chief sources of this inflammation are the alimentary canal and the internal female genital organs.

Any part of the alimentary canal from the cardiac end of the stomach to the extraperitoneal portion of the rectum may be the starting-point for a peritonitis. Peritonitis which starts from the intestine is especially important on account of its frequency and on account of its virulence. This is due to the number of germs within the intestine, and especially to the different forms of bacterium coli, as well as to the presence of ferments and toxins in abundance. The experiments of Cushing and Livingood have shown that in the upper portion of the intestinal canal bacteria are relatively scanty, and that fasting will often produce a sterile or nearly sterile condition of these parts. This fact helps to explain the difference in virulence of different attacks of peritonitis.

Perforation may take place in typhoid, dysenteric, tuberculous, carcinomatous, or syphilitic ulcer. The more rapid the ulceration the greater the risk of diffuse peritonitis. If the ulceration goes on slowly, an adhesive inflammation may be set up which will either prevent rupture into the peritoneal cavity or will be able to encapsulate the discharge.

Traumatic rupture of the alimentary canal is next in importance to ulceration. The effect of the discharge of gastric or intestinal contents into the peritoneal cavity is a violent inflammation with general symptoms. A traumatic perforation is somewhat more favorable in this regard than an ulcerative one, since contraction of the muscles of the intestine may block or narrow the opening in such a manner as to prevent or limit escape of the intestinal contents. This is, of course, only possible in case of a small perforation. Small lesions of the large intestine are less dangerous than those of the small intestine or stomach, because the thicker fecal contents of the former are less likely to escape.

Even when no perforation exists, an inflammatory or ulcerative process of the gastric or intestinal wall may give rise to peritonitis,

since microbes may develop in the diseased tissue until they reach the serosa and spread upon its surface, even though no demonstrable perforation exists.

The commonest cause of peritonitis is disease of the vermiform appendix. In the majority of cases the inflammation is limited by adhesions which are formed around the diseased organs. In other instances perforation is followed by such a violent inflammation that the whole peritoneum becomes infected. An encapsulated appendical abscess may subsequently rupture and set up diffuse peritonitis. Sometimes the transverse colon and omentum oppose a barrier which prevents extension of the inflammation to the upper portion of the abdomen.

The next most common cause of peritonitis is perforation of a gastric or duodenal ulcer. Such an ulcer is usually of the simple type. It may, however, be carcinomatous, or the peritonitis may be due to diffuse inflammation of the gastric wall. Typhoid and tubercular ulcers of the small intestine and tubercular and syphilitic ulcers of the large intestine may also lead to perforation. Foreign bodies which have been swallowed may perforate the wall of the stomach or intestine. Congenital and acquired diverticula of the intestine may become inflamed and give rise to peritonitis. Constrictions of the intestine, by producing dilatation and ulceration of the proximal mucous membrane, may lead indirectly to peritonitis.

Any obstruction of the intestinal canal by which the intestinal wall is injured and the circulation through it shut off may easily bring about perforative peritonitis. This is true of external and internal hernia, obstruction by bands, twists, and invaginations. Within a certain time after such an accident a sero-hemorrhagic exudate results, and a little later bacteria will be able to pass through the intestinal wall even though it is not completely gangrenous. Closure of the mesenteric vessels by emboli, thrombi, or injury will produce intestinal gangrene and peritonitis.

The uterus, ovaries, and tubes are frequent sources of peritonitis. The affections which may extend in this manner are puerperal infection, and catarrhal and suppurative inflammations of the mucous membrane of the uterus and tubes, especially when such inflammation is due to a gonococcus. In puerperal peritonitis the infecting germ is usually a streptococcus. Traumatic or spontaneous rupture of the uterus or the vagina during birth, perforation of the uterus by instruments, and the injection of fluid into the uterus under conditions which allow it to pass through the tubes into the abdominal cavity, are other causes of peritonitis.

Peritonitis may develop from the liver secondary to such infections as cholecystitis, cholangitis, or hepatic abscess or echinococcus, although if the echinococcus cyst is not suppurating the peritonitis will in that case be an aseptic one.

Inflammation and suppuration of the pancreas may give rise to peritonitis. The disseminated fat necrosis so often spoken of in connection

with pancreatitis is probably the result of the digestive power of the pancreatic juice.

In malarial and typhoid fever infectious material may reach the peritoneum through the spleen. Embolic abscesses of the spleen, and suppurating echinococcus cysts of this organ may also cause peritonitis. Twisting of the pedicle of a wandering spleen may cause peritonitis, but more often causes a chronic inflammation of the serosa of the spleen itself—a perisplenitis.

The lymph-glands of the mesentery may be a source of infection; for instance, if they suppurate as a result of absorbed poison in typhoid fever. Suppurating thrombi in the bloodvessels (pylephlebitis) may also cause peritonitis. Infection of the umbilical wound in a newborn child may spread to the peritoneum or peritonitis may follow a suppurating inflammation of the umbilical artery. Suppuration proceeding from the kidney usually affects the retroperitoneal tissue and may secondarily involve the peritoneum. Traumatic and ulcerative perforation of the bladder may cause peritonitis, and abscess of the prostate or of the seminal vesicle; and cellulitis due to urethral stricture, etc., may extend into the subperitoneal tissue and thus affect the peritoneum. In rare cases gonorrhœa in the male is followed by peritonitis, but it is not known by what channel the gonococci reach the peritoneum. Equally rare is an extension of inflammation from the testicle along the vas deferens to the retroperitoneal tissue and the peritoneum. If the tunica vaginalis communicates with the peritoneal cavity, irritating injections into the former may set up inflammation in the latter. Suppuration in the pleura or pericardium may extend to the peritoneum just as suppuration in the peritoneum may extend to these thoracic serous cavities. Erysipelas and cellulitis of the abdominal wall, and suppuration of the spine or ribs or pelvic bones, are lesions which may produce inflammation of the peritoneum.

In the majority of cases peritonitis is due to an extension of infection from some neighboring tissue, or the infection may reach the peritoneum through the bloodvessels. Thus there is a hæmatogenous peritonitis occurring in connection with acute articular rheumatism and nephritis. The occurrence of peritonitis in connection with acute infectious diseases has occasionally been mentioned, but the accuracy of such observations is doubtful.

Benda, who made autopsies in 446 cases of acute diffuse peritonitis, assigned as the starting-point:

Appendix	115 times.
Stomach and duodenum	68 "
The rest of the intestine	118 "
Female genitals	81 "
Gall-bladder	10 "
Kidney and urinary bladder	10 "
Pancreas	2 "
Spleen	1 time.
Unknown	35 times.
Postoperative	4 "
Hæmatogenous origin (nephritis and acute articular rheumatism)	2 "

Symptoms.—Although the causes of peritonitis are so various the clinical picture of the disease is uniform. Peritonitis is almost always secondary to some injury or affection which has already given rise to symptoms before the peritonitis develops. These symptoms may gradually increase in intensity as the inflammation extends to the peritoneum, or the symptoms due to the peritonitis may appear suddenly in a most striking manner as contrasted with the previous mild symptoms. Indeed the symptoms of the primary affection may be slight or altogether absent, so that the patient has not considered himself sick until the onset of the peritonitis. An example of this is the perforation of some intestinal organ which up to that time was apparently in a healthy state.

The peritonitic symptoms vary in degree according to the intensity of the inflammation, and according to the amount of resorption of poisonous material (toxæmia, septicæmia). The severity of the clinical symptoms by no means corresponds to the amount of pathological change of the peritoneum; thus the evidences of inflammation seen after death may be slight although the patient has suffered from the severest symptoms, while in other cases it will happen that the whole peritoneal cavity becomes filled with pus although the symptoms are of mild character. It is not always possible to determine from the clinical symptoms what the nature or extent of the peritoneal inflammation may be.

A patient with peritonitis usually feels very sick. The disease often begins with a chill. The patient cannot keep himself upright. His appearance is anxious, he is restless, and as the disease progresses the skin of the face becomes wrinkled and the nose more pointed, while the eyes sink in. This is in consequence of the decrease of fluid in the body. Still later the face and extremities become cyanotic on account of the sluggish circulation and insufficient aëration of the blood. The patient lies upon his back and avoids any motion which disturbs the abdomen. The knees are often drawn up in order to relax the abdominal muscles. The head and arms are tossed restlessly about.

Consciousness is at first not affected. Later it may be clouded by toxæmia or the patient may become delirious; frequently just before death the state of mind of the patient is a happy one—a most unfavorable symptom. He expresses himself as free from pain and feeling better, although these statements are in sharp contrast to the sunken face, cyanosis, coldness of the extremities, difficult respiration, and the thread-like pulse which shows that the end is near.

The voice is light in the beginning of the disease, as the patient avoids deep respiratory movement; later the voice may become hoarse. Respiration is from the beginning superficial, being costal rather than diaphragmatic, and consequently the rate of respiration is much increased. The character of the respiration is at first determined by the abdominal pain, and later by meteorism, which presses up the diaphragm and makes easy respiration impossible. At

the close of the disease the respiration becomes still more superficial and of a spasmodic, snapping character, which is one of the worst symptoms of peritonitis.

In the stormy onset of peritonitis the pulse is small and depressed on account of the shock; later its rate is increased until it is difficult or impossible to count it. The tension is low and is only slightly increased by the pulse-waves. The inflammation of the serosa stimulates the vagus, the meteorism opposes a mechanical obstacle to the blood circulation, and the poisons with which the blood is surcharged depress the heart muscle. Sometimes the disease progresses to a certain distance before the characteristic rapid pulse is manifest, but usually the pulse-rate is increased from the first. If at the same time the temperature is low, so that the lines indicating pulse and temperature cross upon the chart, a clear indication of peritonitis is present.

The temperature is variable. In those cases which develop in the course of septic disease (puerperal fever) the temperature is usually high. Fever is often absent in severe inflammation with a purulent and gangrenous condition of the peritoneal cavity; for example, after perforative peritonitis. Hence the absence of fever is no proof of the non-existence of peritonitis. Lennander and others have shown that the difference between the axillary and rectal temperature is greater in peritonitis than it is in other conditions.

The activity of the alimentary canal is suspended. The patient has no desire for food, but suffers often from a burning thirst while the stomach rejects even a few drops of fluid. The tongue is heavily coated, and in septic cases is brown and dry.

The excretion of urine is diminished, since much fluid is lost by vomiting and little or none is absorbed through the stomach. In consequence the urine is scanty, concentrated, and often contains traces of albumin and indican.

In addition to these general symptoms there are local symptoms which are more or less directly dependent upon the inflammation of the serous membrane. While the healthy serous membrane which covers the viscera has little sensitiveness, as can be demonstrated at abdominal operations when local anæsthesia is employed, it becomes very sensitive when inflamed; consequently abdominal pain is an almost constant symptom of peritonitis. Indeed, this pain, which may be so great as to produce a condition of extreme shock, is usually the first alarming symptom. It is most marked in the affected region; thus, in case of gastric perforation it is found in the epigastrium or left hypochondrium. In perforation of the appendix it is found in the right iliac fossa, and in the case of pelvic inflammation it is situated in the pelvis. As the peritonitis develops the pain spreads over the whole abdomen, although it is frequently most intense in the seat of the original trouble, and is most increased when pressure is made upon that region. Sometimes a patient is unable to localize the pain, which he describes as being situated around the umbilicus. In the beginning of the trouble this localization of the pain is a fairly certain guide to the

affected organ ; later in the disease such an inference is less valuable. The intensity of the pain varies according to circumstances. In rare cases it is altogether wanting, so that the diagnosis of peritonitis is made with a good deal of doubt until a purulent exudate makes it a positive one. The pain is usually constant, or it can be produced by the lightest touch upon the abdomen, by the slightest jarring or motion of the body, and especially by any intestinal movement. Palpation of the abdomen in diffuse peritonitis is everywhere painful. The intenssity of the pain is often much diminished when an abundant exudate has formed. As the patient becomes more and more intoxicated by the poison of the disease the pain, whether spontaneous or caused by pressure, is noticed less and less, and often not at all.

The second local symptom of inflammation of the serosa is the formation of an exudate whose quantity and character vary greatly. In general it may be said that the more violent the attack of peritonitis and the more marked the symptoms of general sepsis, the less will be the local reaction of the serosa. Under such circumstances the membrane is injected and cloudy and covered with a thin coating of fibrin, while the peritoneal cavity contains only a few spoonfuls of cloudy grayish-red fluid situated in Douglas's pouch. Such are the conditions found in the very worst cases of septic peritonitis in which the peritoneum does not have time to reach a more marked condition of inflammation. If the acute attack is less violent, an exudate will be formed which is at first purulent and later may become gangrenous. The intestinal coils become matted together with the abundant deposit of fibrin. There are also cases of acute infectious peritonitis in which the exudate has a serous character. A non-infectious chemical or mechanical peritonitis is accompanied by a serofibrinous exudate which may have a hemorrhagic character.

The quantity of exudate may be very small, or it may be very large—several litres (quarts). On account of the meteorism which is usually present, it is difficult to demonstrate the presence of small quantities of fluid, and even larger quantities may be overlooked since the distended and adherent intestinal coils float upon the fluid. The presence of fluid is shown by dulness on percussion over the most dependent portion of the abdomen, the dull area shifting its location with changes in the position of the patient. It should be borne in mind that coils of intestine which are full of fluid will sink to the lowest part of the abdomen, while coils which are distended by air will naturally rise above them. On this account it is not always possible to say whether dulness on percussion is due to free fluid or to fluid in the intestinal coils. If the dull area shifts readily as the position of the patient is changed, it is probably due to free fluid. If pressure with the fingers upon the dull area produces a gurgling sound, the dulness is probably due to fluid in the intestine. But here again one must remember that there may be free gas as well as free fluid in the abdomen after perforation. Fluctuation is a sign not usually obtained in the acute stage of peritonitis on account of the rigidity of

the abdominal muscles. In a chronic stage of fibrinopurulent peritonitis, when large abscess cavities have formed between adherent coils of intestine, fluctuation is not uncommon. A finger placed in the rectum or in the vagina will often demonstrate the presence of a deeply placed collection of fluid.

Aspiration for the purpose of diagnosis is dangerous because a puncture may be made in the distended and inflamed intestinal loop which is not readily closed. Furthermore, if the aspirated fluid is straw colored, thin, and has a strong fecal odor, it is often difficult to say whether it is simply an exudate or an exudate mixed with the contents of the small intestine. If under the microscope it is seen to contain a great number of pus-cells, it is probably an exudate; whereas if it contains portions of food, a gastric or intestinal perforation must exist.

Sometimes a fibrinous exudate manifests itself by a soft crepitus which may be felt or heard over the surface of the liver, or the surface of the cyst, or possibly elsewhere. This crepitus is similar to that produced in a dry pleurisy.

Gas may enter the peritoneal cavity from the stomach or intestine in the case of perforation; or in rare cases as a result of fermentation in the exudate. The gas-bubbles have a tendency to rise to the apex of the abdomen, but it is extremely difficult to say before the peritoneal cavity is opened whether the resonant area which shifts with changes in the position of the patient is due to free gas or to gas in the intestinal coils.

While pain and the formation of an exudate are the direct local results of inflammation of the serosa, vomiting and intestinal paralysis may be described as its indirect local results.

Vomiting is a cardinal symptom of peritonitis which is rarely absent. Nausea, eructations, and vomiting form a group of symptoms which are usually present at the very beginning of the inflammation. However, there are cases of acute perforation of the stomach in which vomiting is absent. The first vomitus consists of the food in the stomach and later of mucus and bile which is brought up after a terrible retching. Every attempt to take food, or even a small quantity of fluid, excites renewed vomiting. In other cases vomiting occurs at long intervals, so that whatever has been taken into the stomach becomes mixed with mucus and bile and the whole is thrown violently out in one act of vomiting. Absorption from the stomach is suspended, so that medicines which are administered are without effect. If the intestine is also paralyzed, vomiting may be of a fecal character, since the contents of the upper coils of small intestine may be forced back into the stomach. Between the attacks of vomiting the patient is often disturbed by a spasmodic hiccough.

The vomiting which occurs in peritonitis is of a reflex character, being caused by the inflamed condition of the serosa; consequently it is just as prominent a symptom when the inflammation is situated in some portion of the abdomen other than the epigastrium.

Hiccough is another reflex symptom, and is explained by the fact

that sensory fibres of the phrenic nerve are distributed to the peritoneum, and that through them the motor fibres of the diaphragm are excited to action. Inflammation of the peritoneum affects the whole intestinal tract as well as the stomach. The intestinal muscles are paralyzed and peristalsis stops. It is true that in the beginning of the disease there is still some intestinal action, so that a patient often complains of pain caused by the passage of gas from one intestinal loop to another. Even when the peritonitis is well developed auscultation may show that there is some movement of gas and feces, but such slight motions being limited to small portions of the intestine are of no assistance in moving the whole fecal stream downward. At a later period of the disease all peristalsis ceases.

The failure of the passage of gas and fecal matter through the anus is an important early symptom of acute peritonitis. Perhaps in the beginning of the disease matters which have collected in the rectum may be ejected, but afterward there is no movement of the bowels. Cathartics increase the pain but have no other result. In some forms of peritonitis, especially in the puerperal septic form, the patient is troubled with diarrhœa. Stoppage of the fecal stream brings about abnormal fermentation and gas formation, so that the paralyzed intestine is greatly distended. This meteorism stretches the abdominal wall and presses the diaphragm upward, and by these means greatly interferes with respiration and blood circulation. The liver is pushed upward until its sharp lower edge is directed forward and the area of hepatic dulness is greatly decreased. The distended intestine may be forced into an old hernial sac, if such exists, and this has been known to mislead the surgeon into thinking that the peritonitis was due to strangulated hernia. Examination will show that such a hernia is easily reduced, while reduction of a strangulated hernia is, of course, impossible. Intestinal paralysis and meteorism are not always present in the beginning of peritonitis, but the cases are few in which they do not later develop and become marked symptoms. There are, however, well-authenticated instances in which peristaltic action has been preserved throughout the disease. The intestinal paralysis is in part due to reflex action, and is in part the direct effect of the inflammatory swelling of the intestinal wall.

The function of the bladder is often interfered with in case the peritoneum which partly covers its fundus is inflamed. Micturition may be painful or it may be quite impossible.

The anterior abdominal muscles are strongly contracted. This again is a reflex contraction due to the pain arising from the inflamed serosa. In the beginning of a peritonitis, especially in cases of perforation, the abdominal muscles are so firmly contracted that they seem to be drawn inward. This contraction continues even after the abdomen has become distended, and it is not in the power of the patient to relax his abdominal muscles.

Symptoms of Special Forms.—The symptoms given above are the typical symptoms of a diffuse extending peritonitis. They vary more

or less according to the origin and the intensity of the process. If the inflammation is accompanied by general sepsis, as is usually the case in puerperal peritonitis and in peritonitis following operation, the symptoms of a general intoxication overshadow those of the peritonitis itself. The patient is stupid, the heart action is extremely rapid and weak, respiration is snappy, and the tongue is dry—all symptoms of a severe septic poisoning. The local signs of peritonitis—pain, exudate, and vomiting—are less marked. Intestinal paralysis is usually present, though there may be diarrhœa, a result of the poisonous toxins.

Peritonitis which is due to the sudden rupture or traumatic opening of some hollow abdominal organ begins with an extremely painful attack. The patient has the feeling that something within the abdomen is tearing apart. Shock is a marked symptom. The abdominal muscles are firmly contracted, the abdomen is sunken, the pulse is small and depressed. As the symptoms of shock pass off those of beginning peritonitis show themselves, and there are vomiting, general abdominal pain, meteorism, etc. If the stomach or intestine is perforated, free gas may accumulate in the peritoneal cavity. Vomiting may be absent after perforation of the stomach.

In counterdistinction to an acute attack described above, the inflammation may spread slowly and gradually over the whole peritoneum or a greater part of it. This is the progressing fibrinopurulent peritonitis described by Mikulicz. In this form of disease there will at first be more or less local pain, which will spread until the whole abdomen is extremely sensitive. Such is the case if an encapsulated abscess breaks through the protecting adhesions and the inflammation develops in an increased area of the abdomen. Sometimes inflammation situated below the umbilicus will be shut off by adhesions at the level of the transverse colon. Such an inflammation will produce the usual signs of diffuse peritonitis, because nearly all of the small intestine is involved. If, however, the inflammation is limited to the upper part of the abdomen, general symptoms may be wanting for the reason that so little of the small intestine is affected.

An acute purulent inflammation may pass into a chronic form. If such change occurs, the violence of the symptoms subsides and pain and vomiting become less or occur only at longer intervals. The local signs of a fluid exudate become more and more marked, and the patient often shows in the remittent type of fever the fact that there is an encapsulated abscess in the abdomen.

Well-localized inflammation in the peritoneum, such as occurs in connection with appendicitis, perimetritis, etc., is marked by diffuse pain, vomiting, meteorism, and rapid pulse. These general symptoms subside more or less in a day or so, and leave only such symptoms as are due to localized inflammation in the neighborhood of the diseased organ. An early operation in such cases will reveal an encapsulated abscess, while the rest of the peritoneum may contain an inflammatory serous exudate which is possibly sterile and hence may be resorbed.

Non-infectious peritonitis due to chemical or mechanical causes is characterized by intense pain, vomiting, intestinal paralysis, and formation of an exudate. Symptoms which depend upon general intoxication are wanting.

Diagnosis.—It is difficult to determine in the beginning of the disease whether the inflammation is diffused or circumscribed. Moreover, the passage of a biliary or nephritic calculus or acute gastritis or enteritis may cause symptoms which are scarcely to be distinguished from those of a commencing peritonitis.

The pain due to a calculus is most intense in the neighborhood of the calculus, from which point it spreads out over the abdomen. A calculus may also cause violent vomiting. Pressure on other portions of the abdomen is not painful. There is little or no abdominal distention. The abdominal muscles are not so contracted in other portions of the abdomen. It is true these general abdominal symptoms may be wanting in the beginning of an acute peritonitis, but a little delay will suffice to bring them into prominence.

An acute enteritis is usually accompanied with diarrhœa, which, as already stated, is a rare symptom in peritonitis; while such symptoms of peritonitis as abdominal rigidity, meteorism, and increased rapidity of pulse and respiration, are wanting.

Uræmia may simulate peritonitis, especially if the patient is unconscious and groans when his abdomen is touched. The absolute suppression of the urine which is seen in uræmia does not occur in peritonitis, or, if a small quantity of urine can be obtained in uræmia, the presence in it of albumin, blood, and casts will indicate the nature of the trouble. Cerebral symptoms, such as unconsciousness and spasms, are also characteristic of uræmia and not of peritonitis.

Intestinal obstruction produces a condition more like peritonitis than any of the diseases mentioned. The violent and finally fecal vomiting, the paralysis of the intestine, and distention of the abdomen are common to both peritonitis and intestinal obstruction. Obstruction may lead to peritonitis, but before it does so an important differential point is the absence of tenderness in all portions of the abdomen excepting that in which the obstruction lies. The abdominal muscles are less rigid, so that the outline of the intestinal coils may be observed, which is never the case in peritonitis. In the beginning of intestinal obstruction pain may be spontaneous, coming on in cramp-like attacks accompanied by gurgling and violent peristaltic contractions which may be visible through a thin abdominal wall. These symptoms, if seen in peritonitis, are of a milder character. In the later stage of intestinal obstruction the intestine is paralyzed, usually as a result of gangrene and peritonitis. Fever is wanting in intestinal obstruction up to the time when inflammation develops. Fever may also be wanting in peritonitis, so that the absence of fever is not so significant as its presence in differentiating between these two conditions. The presence of an inflammatory exudate is not easily demonstrated for the reasons given above. If it is present, it points to peritonitis rather

than to intestinal obstruction. Leucocytosis indicates inflammation rather than mechanical obstruction. Intestinal paralysis and meteorism are common to both affections, although in obstruction it is often localized, while in peritonitis it is diffuse. If mechanical obstruction exists, it is usually absolute, so that neither feces nor gas passes per anum; or, if gas be passed either spontaneously or after an enema, it usually indicates that the obstruction is overcome, and if so the symptoms quickly subside. In peritonitis gas and some fecal matter may be obtained by an enema without noteworthy relief of symptoms. The general condition is better in obstruction than in peritonitis. Thus it is evident that in a number of cases of uncomplicated obstruction a differential diagnosis can be made. This is usually impossible as soon as peritoneal irritation complicates the intestinal obstruction. Such a complication is not long delayed if the obstruction is one which threatens the integrity of the intestinal wall. As soon as the vitality of the intestinal wall is lost it becomes pervious for bacteria and toxins, and infectious peritonitis rapidly develops. When such complication arises, the distinguishing marks between the two conditions are rapidly obliterated.

Prognosis.—Diffuse peritonitis is a very serious disease whose outcome cannot be prognosticated with certainty. In general it may be said that the outlook is more grave if the symptoms of general intoxication are prominent. These symptoms are disturbances of consciousness, cardiac failure, snappy respiration, cyanosis, and cold extremities. The termination of septic peritonitis or peritoneal sepsis, as this form of disease is sometimes called, is almost inevitably in death. The prognosis of perforative peritonitis is also grave unless an operation is promptly performed. Even then the result is uncertain, since so much depends upon the extent and character of the inflammation and the resisting power of the individual. In those cases in which there is an active reaction of the serosa and the formation of a purulent exudate the prognosis is somewhat better than it is in the cases in which the inflammation spreads rapidly, without formation of considerable exudate. But even the cases of acute purulent peritonitis if left to themselves usually terminate in death. Still instances occur in which the acute stage passes over and the disease assumes a chronic form and the localized abscesses discharge spontaneously or with the help of a knife, and the patient recovers. Until such abscesses are relieved the prognosis is in doubt, for one cannot say whether the system will be able to bear the poisonous material which it will have to absorb in order to bring about recovery. While the prognosis is therefore always grave, in rare instances patients recover from conditions which seemed absolutely hopeless.

The outlook is more favorable if the patient is suffering from non-infectious peritonitis due to chemical or mechanical causes. Even though the inflammation is at first a violent one, it will usually terminate in recovery unless pathogenic organisms enter the hitherto sterile exudate.

Treatment.—In every case of peritonitis, whether circumscribed or diffuse, absolute rest for the body as a whole and for the intestinal tract in particular is of the greatest importance. The patient should be put to bed and all motion and jarring should be avoided, partly to spare the patient pain, and partly to avoid any increase of peristaltic action which in its turn can spread the infection still further. The best position is one of dorsal decubitus.

In order not to excite pain and vomiting, nothing should be given by mouth except the smallest possible quantity of fluid nourishment. Milk, tea, coffee, or gruel may be given by the spoonful. The patient may rinse his mouth with water or carbonated water, or he may be given rectal injections of 150 to 200 c.c. (5 to 7 ounces) of water for the relief of thirst. Most patients prefer cold drinks, although in collapse very hot drinks given in small quantities are better than cold drinks or bits of ice. In peritonitis the absorbing power of the stomach is greatly diminished, so that it is often desirable to administer fluid nourishment and medicine by the rectum or subcutaneously rather than by the stomach.

An ice-bag may be placed upon the abdomen to relieve the pain. Some patients prefer hot applications. The effect of both is similar, since both dilate the cutaneous vessels and draw blood from the hyperæmic serosa. If the weight of an ice-bag or cold-water coil is too great, a compress wet with an evaporating lotion may be kept on the stomach.

Opium and its derivative, morphine, are more used than other drugs, and cannot be entirely dispensed with, since it is often necessary to control pain and obtain the necessary bodily and intestinal quiet. The majority of acute cases of peritonitis start from the appendix, and if the intestine can be kept at rest adhesions will have time to form and prevent the spread of inflammation throughout the abdomen. For this purpose in every case of beginning peritonitis one can safely administer 15 to 20 drops of tincture of opium every three or four hours until the pains subside. If it is evident, however, that there has been perforation of the stomach or of the intestine into the free abdominal cavity, an immediate operation is preferable to the treatment by opium. The administration of laxatives in the beginning of peritonitis is ill-advised, as likely to increase peristalsis and spread the inflammation. This is especially true in cases of appendicitis.

If in spite of the treatment by opium the peritonitis is extending and there are intestinal paralysis, meteorism, and a purulent secretion in the abdomen, opium will not benefit, but will rather injure the patient by increasing the intestinal paralysis. At this period of the disease morphine given subcutaneously is preferable to opium.

Vomiting and dilatation of the stomach can sometimes be relieved by washing out the stomach. The organ will be freed from fermenting material, mucus, and regurgitated bile, and the patient will feel much easier. Moreover, there will be less vomiting and the tension in the upper part of the abdomen will be decreased. Sometimes this gastric

lavage improves the condition of the pulse and respiration. It should always be carried out with a soft tube and lukewarm water or salt solution. A small quantity of the fluid may be left in the stomach to relieve thirst. This treatment is naturally counterindicated if there is reason to suppose the stomach has been perforated. As stated above, intestinal movements are undesirable in the beginning of peritonitis; later, when the intestine is paralyzed and meteorism develops, the rectum should be irrigated with lukewarm water in order to get rid of gas and fecal matter, and so diminish the tension of the abdominal wall. A second object is to prepare the rectum for the administration of a nutrient enema consisting of one egg, 100 grammes (3 ounces) of milk and an equal quantity of water, a dessertspoonful of brandy, and a little salt. If irrigation with an indifferent fluid produces no effect, the injection may be repeated with water containing turpentine, glycerin, or soap. The administration of nourishment by the rectum is far more serviceable in keeping up the patient's strength and combating collapse than the administration by mouth of coffee, tea, or alcoholic stimulants. Such drinks are almost certain to be vomited after a time, and it is doubtful whether any part of them is absorbed by the stomach.

Morphine injected subcutaneously frequently improves the pulse. Ether and oil of camphor, 1 part to 9, and strychnine nitrate are stimulating remedies which may be used subcutaneously. More recently large subcutaneous injections of saline solution have been recommended by Michaux. He uses a saline solution of the strength of 6 to 9 parts in 1000 in sterile water, and makes it slightly alkaline with a drop or two of solution of sodium hydroxide. From 200 to 250 c.c. (6 to 8 ounces) of this solution are injected in the subcutaneous tissue beneath each clavicle by means of an irrigator or a syringe. The fluid is rapidly taken up and the pulse improves. After six to eight hours the injection may be repeated in other portions of the body, such as the side of the thorax or the thigh. This treatment causes little or no pain. The subcutaneous injection of antistreptococcic serum has been recommended in cases of peritonitis due to streptococcus, but the results of this treatment are yet in doubt.

The treatment thus far outlined is calculated to relieve certain symptoms and maintain the strength of the patient, but it has no value in overcoming the inflammation of the peritoneum, so that the disease may progress to a fatal termination in spite of it. The progress of abdominal surgery and the results obtained by the operative treatment of circumscribed peritonitis led surgeons to hope that a diffuse peritonitis might also be treated surgically.

Operative treatment is designed to accomplish the following objects: 1. It may remove purulent or gangrenous exudate and afford easy escape for future secretion. The patient will therefore be spared the resorption of much infectious material, while the lessening of intra-abdominal pressure will facilitate resorption and circulation of the blood. 2. The affected organ from which the peritonitis has spread

may be exposed and sutured or removed. This applies to the stomach, intestines, tubes, ovaries, etc. Any general infection of the system which has already taken place at the time of operation will not be affected by it. Furthermore, it is impossible to disinfect such a large irregularly shaped serous cavity as that of the peritoneum, and irrigation and sponging can accomplish nothing more than a mechanical cleansing.

Such are the indications for and limitations of operative treatment of peritonitis. This treatment is powerless in cases in which sepsis is the prominent symptom while the formation of an exudate is scanty, but in cases of purulogangrenous, of fibrinopurulent, and of perforative peritonitis the results obtained by operation are very good. But, as above stated, it is often impossible to tell from the clinical symptoms what form of peritonitis exists.

It is naturally of the greatest importance to determine the starting-point of a peritonitis, but unfortunately this can only be done with a certain degree of probability, especially if the patient is first seen some time after the trouble began. Under such circumstances one should make it an invariable rule to inquire with care into the previous history of the patient, as well as to determine by accurate examination in what part of the abdomen pressure causes the greatest pain or did cause it in the beginning of the trouble.

It is difficult to give any general rule when operation should be undertaken for peritonitis. If there is reason to suppose that any hollow organ has perforated, operation should be performed at once in order to prevent spread of the inflammation. In other cases, and especially those in which inflammation starts from the appendix, the question is not so easily answered. In some of these cases the onset is very acute, and yet the symptoms quiet down and the patient recovers. Hence one hesitates to advocate immediate operation under such circumstances. These patients should be watched with the greatest care. Burkhardt gives the rule to operate whenever it appears from the whole group of symptoms that the inflammation is spreading.

The technic of laparotomy for peritonitis is variously given. The following points are worth consideration :

In addition to disinfection of the skin of the abdomen, the stomach should be washed out provided there is no reason to suspect a gastric ulcer. The large intestine should be irrigated and such hypodermic or rectal stimulation given as the condition of the patient demands.

The great tenderness of the inflamed peritoneum makes general anæsthesia desirable, especially if it is necessary to handle the abdominal organs. Furthermore, a conscious patient may by straining add to the difficulty of the operation, although for an incision through the abdominal wall local anæsthesia is quite sufficient. The position and length of the abdominal incision depend on the cause of the inflammation. If there are no special indications, a median incision is preferable, since it affords the best view of the whole abdominal cavity.

In the early days of laparotomy for peritonitis the object sought

was simply the evacuation of pus. For this purpose an incision of 10 cm. (4 inches) is sufficient. Through such an incision the operator can insert his hand and examine the abdominal cavity. But experience has shown the advantage of inspection of the different organs, and hence a longer incision is preferred by most surgeons. If the patient is feeble, the incision should be made as short as will suffice, since it can be enlarged during the operation if necessary. The escape of pus through the incision may be facilitated by turning the patient on his side or by passing the hand into the region in which the pus has collected, especially in the pelvis, or iliac fossæ, or subphrenic space.

If the condition of the patient permits, the origin of the inflammation is always to be sought for and the injury repaired.

Surgeons are not yet agreed upon the efficacy of abdominal irrigation, although there is a common understanding that antiseptic irrigation is harmful. If any fluid is used for irrigation, it should be a hot sterile saline solution of the strength of 0.6 per cent. This practice is strongly advocated in England and America and by some Continental surgeons. Lennander believes that saline irrigations at a temperature of 40° to 50° C. (104° to 122° F.) have a stimulating action upon the heart, and Rehn says that they improve the tone of the paralyzed intestine. Wiping the intestine with dry gauze appears to injure the serosa more than irrigation and wiping with moist gauze.

If most of the intestine remains in the abdominal cavity, irrigation is carried out by introducing two rubber or glass drains into the different spaces and pockets of the abdomen. One of these drains is connected with the irrigator, and the other with a tube which leads to a slop-jar. By this means the fluid flows out and in at the same time. Irrigation should be continued until the fluid flows out perfectly clear, one after another of the different portions of the abdomen being cleansed systematically. Some surgeons advocate bringing the small intestine out of the wound in order to wash it with hot salt solution and wipe it with gauze. Such a procedure is only advisable in case the heart is acting well, since this eventration and handling of the distended intestine can so depress a weak heart that its action ceases. Rapidity of operation is essential in these cases. The principles of treatment, as already stated, are evacuation of pus, irrigation with hot saline solution, and wiping the peritoneal cavity with clean gauze.

In cases of intestinal perforation seen not many hours after the accident, before meteorism has developed, the best treatment is to suture the perforation and cleanse the peritoneal cavity with or without eventration.

If the intestine is greatly dilated, it may be difficult to replace it. The best way to accomplish this is to place a linen napkin under the coils of intestine after introducing the lower edge of the napkin into the abdominal wound. By this means those coils of intestine which are replaced will be prevented from slipping out again. Some surgeons have punctured the intestine under such circumstances, while

others advocate an enterotomy in order to relieve distention and facilitate peristalsis. McCosh advises the injection of magnesium sulphate directly into the exposed intestine in order to increase peristalsis.

The subject of counteropenings has been much discussed. Rehn passes a drain from one side of the abdomen to the other through the mesentery. By means of such a drainage-tube he frequently irrigates the peritoneal cavity during convalescence. Counteropenings seem advisable when drainage through the principal wound is not satisfactory. Thus in women it is often advisable to drain through Douglas's pouch. Although some operators close the abdomen after operation for suppurative peritonitis, the majority of surgeons advocate free drainage in order to permit escape of such secretion as may be formed after the operation. If the abdomen is closed and the peritoneum is not able to take care of the bacteria and toxic products which are left within its cavity, inflammation will spread. Drainage can be secured in a variety of ways. Some surgeons leave the wound entirely open; others employ the handkerchief drainage recommended by Mikulicz. Still others introduce rubber tubes or gauze wicks in those regions in which there is the most pus.

The abdominal wound may be partially closed, or deep silver wire sutures may be introduced and loosely twisted in order to prevent prolapse of the intestine. If this is done, the wall may be more tightly closed a few days later, when suppuration has ceased. Occasionally there is an abundant seropurulent discharge for a few days, and sometimes the discharge clogs the drain. The drain should then be removed. Gauze tampons should be taken out as soon as they are loosened. The abdominal scar is made weaker if the tampon is kept in the wound, and ventral hernia will be likely to develop later. Of course, it is possible to excise the scar at a later period and suture the fresh wound exactly.

The after-treatment is very important and the patient should be closely watched. The shock from the operation should be combated by external heat, subcutaneous and rectal injections of stimulants and saline solution. Small quantities of hot drinks may be given by mouth as soon as the tendency to vomit has ceased. If vomiting persists, gastric lavage is beneficial. The cavity of the intestine should be stimulated by rectal injections. Sometimes puncture or drainge of a distended intestinal loop helps to overcome meteorism. Normal evacuation of the bowels is a good indication of recovery. No opium should be given, but injections of morphine if the pain is very great. It often happens that an abscess cavity must be opened during the period of convalescence. Such an abscess forms in the remains of an infectious exudate and is shut off by adhesions from the general peritoneal cavity. The subphrenic space and pelvis should be especially watched for the formation of these abscesses. The inflammation may extend to the pleura and less often to the pericardium. If there is a free discharge of pus from the abdominal wound, and especially if the discharge is of a fecal character on account of primary or secon-

dary intestinal perforation, the patient may be treated advantageously in a continuous water-bath after the second week.

Most surgeons are agreed upon the general indications for operation in suppurative peritonitis, but their methods of carrying out the treatment for this condition are still quite different. Various methods have many times been followed by recovery, but such a fortunate result is not obtained in more than a third of the cases. Further experience must show whether any one method proves itself to be so far superior to other methods that it must be considered the natural one to follow. In many fatal cases the abdomen is found to have been thoroughly cleansed, so that the death of the patient may be considered to have been due to the absorption of too great a quantity of poison, or to the fact that the heart was not able to withstand the shock of operation.

Treatment in Special Forms.—Peritonitis starting in the appendix is the commonest form of this trouble, and its prognosis is relatively the best. It results from either perforation of the appendix or from rupture of a peri-appendicular abscess or by extension of the inflammation through the lymph-vessels. The exudate is usually purulogangrenous, although not infrequently it is fibrinopurulent. The inflammation involves usually the middle and lower portions of the abdomen, and is often limited by the transverse colon and omentum, so that the upper portion of the abdomen is not infected. It is probably on this account that the prognosis is more favorable than in other forms of peritonitis. The diagnosis rests upon the history of previous attacks of appendicitis, and upon tenderness in the right iliac fossa, where there is often increased resistance. If the cause of the peritonitis seems certain, incision should be made over the appendix along the external margin of the right rectus muscle. The cæcum can also be reached through an incision in the median line, and through such an incision the pelvis can be better explored. The diseased organ should be removed when this can be accomplished without too great delay. If there are intense meteorism and symptoms of collapse, resection of the appendix had better be postponed to a later date, when it can be accomplished with much less danger. Special attention should be directed to the right and left lumbar regions and to the pelvis in carrying out irrigation and drainage.

The percentage of mortality as given by different surgeons varies from 28.5 to 38 per cent. Some surgeons include in their statistics cases of encapsulated abscess in which the general abdominal cavity was not opened at operation. Such cases cannot, of course, be considered diffuse peritonitis.

Perforation of an ulcer of the stomach or duodenum may occur without suspicion of existing ulcer. In other cases hemorrhage from the stomach or other symptoms have pointed to the presence of ulcer. Perforation produces intense pain in the epigastrium. The abdominal muscles are rigid and the symptoms of shock develop, to be followed within a few hours by the signs of peritonitis. The picture

is clear enough at an early stage of the trouble. If the patient is seen after a lapse of hours, a correct diagnosis is not so easily made, and such a patient has sometimes been operated upon for appendicitis. The peritoneal exudate has no odor or perhaps only a slightly sour smell, and the peritoneal cavity often contains free gas. Vomiting may be wholly wanting.

The only treatment for perforation of a gastric or duodenal ulcer which offers the patient any chance of recovery is immediate operation. One should not wait for the shock to pass off. An injection of morphine to still the pain may produce temporary improvement, but it is inadvisable, since it is likely to postpone operation until the most favorable time for it has passed. A suitable incision should be made in the median line, and to this a lateral incision may be added if necessary. Experience has shown that 80 per cent. of perforating ulcers are situated in the anterior wall of the stomach, so that this portion of the organ should first be examined from the duodenum to the cardia. If the perforation is not found, the gastrocolic ligament should be torn through to permit examination of the posterior wall. Sometimes escaping gas or fluid guides the surgeon to an opening in the stomach. It should be closed with two or three rows of serous sutures. One should not stop to cut away the edges of a perforation unless the condition of the patient is excellent. If the serosa is so brittle that the thread cuts through, it may still be possible to close the opening by stitching omentum over it. If suture is impossible, gauze drainage may be employed. Recovery has followed this treatment. It is well to bear in mind that two or more ulcers may exist, and that a second one may be just ready to perforate. When the opening has been closed, the peritoneal cavity should be thoroughly cleansed by irrigation with warm sterile salt solution and wiping with gauze. Since the suture heals the perforation, but not the ulcer, the after-treatment should be such as will cure this trouble. In many cases patients recover from the peritonitis but die later from hemorrhage or a second perforation.

The statistics of Weir and Foote show clearly that the prognosis depends in great measure upon the promptness with which an operation is performed. Thus the mortality after operation performed in the first twelve hours was 79 per cent., whereas the mortality of operation performed between twelve and twenty-four hours was 76 per cent., and of that performed after twenty-four hours 87 per cent. Statistics collected by Tinker show a general mortality of 35.7 per cent. after operation. The prognosis is naturally better if the stomach is empty at the time of perforation.

The prognosis of perforation due to typhoid ulcer is particularly unfavorable because the patient is already suffering from a severe disease. Internal treatment cannot save a patient under such circumstances unless adhesions have already formed about the affected intestine before perforation takes place. The results of surgical treatment are slightly better. Thus in 1901 Loison reported 90 cases with 16 recoveries. Perforation of a typhoid ulcer is marked by a sudden

intense pain in the abdomen followed by shock. There is often a sudden drop in temperature if fever existed at the time of perforation; or there may be a chill and a sudden rise in temperature. Perforation is to be looked for in the lower part of the ileum. An incision should be made from the umbilicus downward in the median line. The perforation should be sutured and the lower portion of the abdomen quickly irrigated. Owing to the weak condition of such a patient the whole operation should be carried out as gently and quickly as possible. Peritonitis occurring in typhoid fever may also be due to the rupture of an abscess in a mesenteric lymph-gland or in the spleen.

General peritonitis spreading from diseases of the female pelvic organs is not usually amenable to operative treatment. If it starts from puerperal fever, it is usually only one symptom of general sepsis. There are cases in which the patient outlives the sepsis and a large abscess remains in the abdominal cavity which may require drainage either through the abdominal wall or through the vagina. Sometimes a tube which is distended with pus bursts and gives rise to peritonitis, while in other cases the peritonitis is secondary to an ovarian abscess or perimetritic suppuration. Under such circumstances an incision in the median line gives a far better view of the diseased parts than a colpotomy. In such cases the best drainage is through the posterior vaginal vault. The diseased tube or ovary should be removed if all its attachments can be safely ligated. If it is surrounded by vascular adhesions, it is better to postpone its removal until the general peritonitic symptoms have subsided. In peritonitis secondary to gonorrhœa of the female pelvic organs it is better to wait, since this trouble is not infrequently recovered from.

Post-operative peritonitis is closely associated with symptoms of general sepsis, and is therefore not favorable for operation. There are cases, however, in which recovery has followed laparotomy with cleansing of the peritoneum and gauze drainage. The earlier custom was to give opium as soon as peritonitic symptoms developed after operation. Many English surgeons, following the suggestion of Tait, have abandoned this practice and now treat peritonitis by the administration of salines and irrigation of the lower bowel. Reichel advocates gastric lavage under such circumstances.

Acute Circumscribed Peritonitis.—The inflammatory processes in peritonitis may become limited by the adhesions which form between opposing serous surfaces. In this manner the peritonitis may remain localized in the vicinity of the affected organ. In character it may be a simple fibrinous one followed by the formation of cicatricial adhesions, or it may be serous or purulent, or gangrenous. A purely chemical or mechanical irritation produces a fibrinous or serous exudate, while a suppurative or gangrenous condition is due to the action of pathogenic organisms. The risk of peritoneal resorption of bacteria and toxins, and also the risk of intestinal paralysis, are far less than in diffuse peritonitis.

The commonest cause of localized peritonitis is appendicitis; next

in order of frequency are diseases of the female genital organs, especially of the tube and ovary. This localized peritonitis is frequently spoken of as pelvic peritonitis. Inflammation of the gall-bladder, usually the result of cholelithiasis, may remain localized in the space bounded by the lower surface of the liver, the gastroduodenohepatic ligament, the duodenum, and the hepatic flexure of the colon with the omentum which is attached to it. If the gall-bladder perforates, an abscess may be formed in this space. Inflammation and suppuration of the pancreas may lead to inflammation which is localized in the lesser peritoneal cavity.

Symptoms.—The onset of a local peritonitis is often associated with symptoms of irritation of the whole peritoneal cavity, such as general pain, vomiting, and moderate meteorism. When the inflammation is well localized, these general symptoms subside and strictly local symptoms are more prominent. In the vicinity of the affected organ there is general tenderness which is much increased by pressure. There is also a more or less sharply defined tumor due to adhesions of serous surfaces, inflammatory thickening of the omentum, intestinal wall, etc. The coils of intestine which are involved in the inflammatory processes are infected, but this paresis does not extend to the rest of the intestine. Consequently gas and fecal matter may pass spontaneously or after an enema. Distention of the abdomen and contraction of the abdominal muscles are confined to the affected locality. Vomiting, which is present at first, usually subsides, although it may continue if the inflammation is in the vicinity of the stomach.

The general condition of the patient who has local peritonitis is far better than that of a patient suffering from diffuse peritonitis. The color and expression of the face, the quiet respiration and clear cerebral action, indicate at once to a skilled observer that the inflammation is localized. The pulse is either normal or moderately increased in rate, and is of good quality. A marked increase in the pulse-rate should always cause a suspicion of spreading inflammation. The temperature may or may not be increased. It cannot be too strongly insisted upon that suppuration in the peritoneal cavity may exist without rise in temperature. However, in most cases an elevated temperature, especially if it is of a remittent type, is suggestive of suppuration.

Course of the Disease.—Fibrinous and serous exudates, even if extensive, are easily resorbed by the peritoneum. Even a firm exudate may in this manner disappear entirely, or it may leave behind it certain thickenings and adhesions. A certain amount of purulent exudate may also be done away with in time. The bacteria die, the fluid is resorbed, and the pus-cells undergo fatty degeneration. There remains for a long time a yellowish mass surrounded by adhesions, but little by little this also disappears. Such a condition is not infrequently found when one operates some time after the existence of a localized peritonitis: for example, in the interval between attacks of appendicitis, or after recurrent attacks of inflammation of the tube or ovary. One ought not to trust to this sort of recovery, as its outcome

is uncertain. It is dependent upon the nature of the primary disease, upon the number and virulence of the bacteria, upon the size of the abscess, and possibly upon other circumstances which are not well understood.

As long as the disease of the affected organ continues and new irritating material is added to the focus of suppuration the abscess tends to increase and may become extensive, although the inflammation is still localized. In this manner the whole pelvis may be filled with pus from the right iliac fossa without symptoms of general peritonitis. If, however, the pus spreads in the numerous spaces between the coils of small intestine and thus affects an extensive serous surface, the symptoms of diffuse peritonitis appear even though the inflammation does not pass the transverse colon and omentum.

A localized process may become general as a result of external mechanical disturbance from without, or as a result of extensive peristaltic action. The pus of a local abscess may also break into the intestine or bladder or vagina, or may bore through into the subperitoneal connective tissue. If it finds its way into the intestine, spontaneous recovery may follow. If the pus enters the subperitoneal connective tissue, very extensive cellulitis may result, or the inflammation may extend to the pleura or pericardium. Another risk of intra-abdominal suppuration is infection of the thin veins of the mesentery with the formation of thrombi, which may break down and give rise to suppurative pylethrombosis. These late results of suppuration cannot be successfully treated, and therefore it is the more important to open an abdominal abscess early.

Treatment.—For the treatment of the organ from which an abdominal abscess arises the reader is referred to the proper chapter. The treatment of the abscess itself will be here described. Such an abscess should be opened as soon as its presence is recognized, provided this can be done without spreading the infection throughout the peritoneal cavity. Serous and fibrinous exudates can safely be left for spontaneous resorption.

The presence of pus in the abdomen can only be shown when the abscess reaches a certain size. The diagnosis rests upon the generally rapid increase in size of the inflammatory tumor, which is painful and very tender on pressure and boggy to the touch, while the pulse and temperature are such as have been described above. The absence of fever is no proof that suppuration does not exist. The development of gas within the abscess cavity may easily be confounded with superimposition of intestine. If the abscess is very deep, so that it is completely surrounded with intestinal coils and cannot be palpated through the anterior abdominal wall nor the rectum or vagina, the diagnosis may be in doubt. The presence of pus can be definitely shown by aspiration. This test has been variously advocated and pronounced dangerous, but if one proceeds aseptically and makes the apiration within the area of palpable adhesions, it is a safe method which will often show the presence of intraperitoneal abscess the existence

of which cannot otherwise be definitely shown. Aspiration should in all cases be followed by operation, so that infectious material may not spread through the wound made by the needle. Bimanual examination with one finger in the vagina or rectum is a valuable means of determining the presence of intra-abdominal abscess. In opening the abscess it is all-important not to break through protecting adhesions and open the general peritoneal cavity. If the inflammatory tumor is attached to the abdominal wall, this danger is easily avoided. In some cases it is of advantage to open the abscess from behind either in the lumbar region or through the vagina or rectum. If the abscess is situated immediately beneath the diaphragm, it is necessary to resect the bony wall of the thorax and to open the abscess through the pleural cavity and the diaphragm. If the general peritoneal cavity must be opened in order to reach the abscess, it should be protected by gauze. When this has been done, the abscess may be opened immediately, or one may wait until adhesions have formed before opening it.

In most cases the operation should consist in simple evacuation of the abscess and drainage, treatment of the diseased organ being left for a later date. For this purpose a short incision usually suffices, and it is of advantage to separate the muscular fibres of the different planes rather than to incise them. The risk of subsequent hernia is thereby reduced. The abscess cavity when opened is washed with sterile water and drained with a tube wrapped about with gauze to prevent pressure-necrosis of the intestine. The tube should not remain too long in position.

If the abscess is very large, a counteropening should be made when possible.

Subphrenic Abscess.—Peritonitis localized beneath the arch of the diaphragm may develop secondarily to disease of several organs. The transverse colon with its mesocolon and the omentum forms a partition to the abdominal cavity, so that adhesions can easily shut off an inflammation above it from the peritoneal space below, or *vice versa*. The upper space contains the stomach, liver, spleen, and pancreas. Injury or disease of any one of these organs may lead to suppuration in the subphrenic cavity. Such a suppuration may also develop from disease of the appendix vermiformis and persist long after inflammation in other portions of the abdomen has subsided.

The liver occupies the right half of the space described and a portion of the left. Its suspensory ligament forms a sagittal partition situated somewhat to the right of the median line. Suppuration in the right side of the subphrenic space is usually due to appendicitis or disease of the liver or gall-bladder or of the right kidney, while suppuration in the left side of the subphrenic space may come from the stomach, duodenum, pancreas, spleen, lung, kidney, or left lobe of the liver.

Etiology.—Inflammation of the appendix may extend to the subphrenic space and set up suppuration in two ways. It may extend

intraperitoneally along the colon until it reaches the edge of the liver; and may extend still farther between the liver and diaphragm. It may also extend between the layers of the mesentery and the vermiform appendix, and then work its way upward in the loose connective tissue behind the cæcum and colon and liver until it reaches the subphrenic space. Injections of staining fluid show how easily inflammation can spread by this route. The attack of appendicitis may be so slight that unless the patient has been frequently seen, or the history of the attack has been carefully inquired into, the cause of the subphrenic abscess may be overlooked.

Subphrenic abscess may be secondary to various processes in the liver and biliary passages. A biliary calculus may set up suppuration in the gall-bladder, causing rupture of the gall-bladder and formation of an abscess either in the peritoneal cavity around the gall-bladder or in the liver. A biliary calculus may set up suppuration in the larger biliary passages, which, reaching the surface of the liver, may involve its peritoneal covering and so give rise to subphrenic abscess. Abscess of the liver of whatever nature (dysentery, pylephlebitis, pyæmia), suppurating echinococcus cyst, or infected wounds of the liver may give rise to subphrenic abscess.

Disease of the stomach and upper portion of the peritoneum is a common cause of subphrenic abscess. If a simple ulcer leads to a slow perforation, the general peritoneal cavity may be protected by adhesions; but if the ulceration continues, suppuration may be set up in the subphrenic space. If the perforation occurs more rapidly, the general peritoneal cavity will become infected and diffuse peritonitis will follow. In rare cases an ulcer in the region of the pylorus will produce an abscess of the right side of the subphrenic space, the abscess first forming beneath the right lobe of the liver and its extension being limited by adhesions. Injury of the stomach or carcinoma seldom gives rise to subphrenic suppuration. If the perforation is a minute one, gas and some infectious material will escape from the stomach, while the coarser particles of food will not find their way into the abscess cavity. When such an abscess is due to gastric perforation, it will be bounded on the right by the suspensory ligament of the liver, below by the left lobe of the liver and the adhesions between the stomach, colon, and adherent abdominal wall, and on the left by the spleen and diaphragm. The diaphragm, of course, bounds it above and the posterior wall of the abdomen behind.

Suppuration around the œsophagus (mediastinitis postica), a result of ulcerative or traumatic perforation, can reach the subphrenic space between the pylorus and diaphragm.

Suppuration in the pleural cavity, especially if it is of gangrenous character, may break through the diaphragm and produce subphrenic abscess. In such cases it is not always easy to determine whether the original process is above or below the diaphragm, since a subphrenic abscess may also perforate the diaphragm and involve the pleura.

Abscess of the spleen, suppurating echinococcus cyst, suppurating

hæmatoma, or suppuration in the head or tail of the pancreas may lead to subphrenic abscess. Such may also be the result of perforation of the transverse colon. Perforation of the intestine beneath the transverse colon gives rise to a general suppurative peritonitis; but if this is of a fibrinopurulent type, it may extend to the subphrenic space and produce an abscess there after the virulence of the inflammation has elsewhere abated. The upper pole of the kidney on either side reaches into the vault of the diaphragm, and therefore subphrenic abscess may follow suppurative pyelitis or suppuration in connection with calculus, or renal abscess, renal tuberculosis, etc.

In a few instances suppuration of the lower ribs or bodies of the vertebræ (osteomyelitis, periostitis) has led to subphrenic abscess.

A subphrenic abscess usually contains free gas, which may be derived from the stomach or duodenum in cases of perforation of these organs, or it may come from the action of gas-forming bacteria.

While the lymph-vessels of the peritoneum do not directly communicate with those of the pleura, still extension of inflammation to the pleura or to the pericardium in case of subphrenic abscess is not rare. The exudate in these spaces may be serous or purulent. In some instances direct perforation into the pleural cavity has been followed by a discharge of pus from the bronchi.

Symptoms.—The symptoms of subphrenic abscess are so indefinite that a diagnosis is often made with difficulty. The disease usually begins with a chill, fever, and intense pain in the upper abdomen. In other cases in which the subphrenic trouble is secondary to chronic appendicitis, cholecystitis, perinephritis, etc., its beginning may be ill defined. The fever is often of the remittent type. The patient is much depressed, feels weak, and loses appetite. If the trouble originates in the stomach, vomiting is common. The abdomen is not distended and not tender to pressure. If the onset is gradual, the only subjective symptoms may be a feeling of pressure and interference with deep respiration. Tenderness on pressure in the intercostal spaces of the affected side or distention of the lower portions of the thorax may point to the seat of the trouble.

Diagnosis.—Diagnosis is made from the history of the disease, from the physical examination, and possibly from the results of puncture. The existence of a previous inflammatory process in the abdomen may usually be determined.

Physical examination of the thorax and upper portions of the abdomen will usually show that the organs have been displaced by the abscess. The diaphragm is displaced upward. If the abscess is situated on the right side, the free margin of the liver is displaced downward to a greater or less extent. The upper margin of the dull area is convex upward and is sharply differentiated from the pulmonary resonance. If the abscess cavity contains gas, which is not often the case in a right-sided abscess, an area of tympanitic resonance will exist between the pulmonary resonance and the dulness due to the liver. This condition when it exists is a most characteristic one. An

abnormally high area of dulness convex upward in the situation of the liver indicates in most cases echinococcus or abscess of the liver or a subphrenic abscess. If the abscess is situated behind the liver, the physical condition is not so striking. The area of hepatic dulness may extend higher than usual, but will not be so distinctly arched. If there is an area of abnormal dulness on the right side, either in front or behind, in a patient whose general condition indicates suppuration and no disease of the pleura or liver can be shown to exist, and especially if the patient has previously had an inflammation in the abdomen one must think of the possibility of a subphrenic abscess, and by means of exploratory puncture ascertain the cause of the abnormal dulness.

The diagnosis is more difficult if the subphrenic abscess is associated with a fluid exudate above the diaphragm. If this exudate is serous, as shown by puncture, the nature of the case may still be recognized; but if the pleural exudate is purulent, subphrenic abscess will hardly be suspected, unless at operation the strongly convex diaphragm is observed. In other cases it is difficult to say whether the collection of pus is situated in the upper portion of the liver or between the liver and diaphragm.

Subphrenic abscess of the left side usually comes from the stomach or duodenum, less often from the spleen, pancreas, or kidney. For this reason most of these abscesses contain gas. If the abscess is situated anteriorly, the epigastric region is prominent and tender on pressure, and one is frequently able to palpate the depressed margin of the left lobe of the liver and the adhesions which have formed about it. The heart is displaced upward, and on the left and posterior side of the thorax there is an increased area of dulness which possibly contains a tympanitic area shifting with the position of the patient if there is free gas. Too much dependence should not be placed upon this symptom, as it is difficult to distinguish between tympanites due to gas outside of the stomach and that due to gas within the stomach. The dulness due to the spleen is continuous with that due to the abscess, while just above the dulness due to the abscess the pulmonary resonance is especially well marked unless there is pleurisy with effusion. This obscures the diagnosis just as it does on the right side. In rare cases when the patient is sitting up one may demonstrate from above downward pulmonary resonance, dulness due to the pleuritic effusion, tympanites due to gas in the subphrenic space, and dulness due to the pus.

Abscess originating in the stomach or duodenum has ordinarily an acute onset. There may or may not have been a history of gastric disturbance. Such a history combined with the results of physical examination will often serve to establish a correct diagnosis. In other cases, and especially if the pleura is simultaneously involved, it will be impossible to say with certainty whether or not a subphrenic abscess is present.

Aspiration with a hollow needle will show whether the exudate is purulent or serous, or due to the presence of echinococcus, while the

depth to which the needle passes will give some idea of the seat of the pus. Such a puncture should be made with a long, medium-sized needle under rigid asepsis. The site usually chosen for puncture is within the dull area at a point where the tenderness on pressure is most marked. The syringe should be attached to the needle, and from time to time, as the needle is slowly introduced, the piston should be withdrawn slightly. When the needle enters the diaphragm respiratory motion will be communicated to it. By this one can tell whether the pus obtained is situated above or below the diaphragm. But this sign will not enable the operator to say whether the pus is between the liver and the diaphragm or in an abscess cavity within the liver. If serous fluid is obtained when the needle enters the pleural cavity and pus when it is pushed deeper through the diaphragm, the diagnosis is sufficiently clear. Sometimes the needle must be inserted in several places before pus is obtained. One should not hesitate to make repeated punctures if the diagnosis of subphrenic abscess seems probable. The risk is slight, far less than the danger of leaving unopened a subphrenic abscess. Operation is scarcely justifiable unless one proves the presence of pus by aspiration.

Treatment.—A subphrenic abscess usually terminates fatally unless it is relieved by operation. Its contents are so foul that resorption is not to be expected, and as long as the abscess exists there is risk of rupture into the general peritoneal cavity, into the pleura, or into the pericardium. Rupture into the bronchi may give relief, but this is so rare an outcome that one cannot trust to its occurrence. Most of the patients die from sepsis or some complicating disease unless escape for the pus is provided. This would be afforded by repeated aspirations. Therefore as soon as aspiration has established the diagnosis the abscess cavity should be freely opened and drained.

A subphrenic abscess may be opened through the pleura or it may be opened from below by an incision along the costal margin.

The transpleural operation is carried out as follows: One or two ribs, usually the eighth and ninth, or the ninth and tenth, are resected for a distance of 6 to 8 cm. (2.4 to 3.2 inches) at the point where aspiration has shown that the abscess cavity may be reached. The condition of the pleural cavity is next determined. If its lower portion is obliterated, the condition is most favorable. If the two serous layers of the pleura are seen to move upon one another during respiration, the pleural cavity must be protected from infection. This can, of course, be done by dividing the operation into two parts so as to allow time for adhesions to form. But this is usually not advisable since the condition of the patient will be injured by the delay. The diaphragm is usually pressed well upward so that one can suture the costal pleura to the diaphragmatic pleura without difficulty. Such a suture is applied in a circle, or, if the stitches will not hold, a circle of iodoform gauze is pressed firmly against the diaphragm and the incision is made in the centre of it. The edges of the wound through the diaphragm and pleura are clamped and drawn forward so that the pleural

cavity may be still further protected. The abscess cavity is washed out with sterile water and drained by a large tube wrapped about with iodoform gauze. In some cases it is desirable to make a counteropening posteriorly. If the pleural cavity contains pus, it must also be drained, and even if it contains serum drainage is advisable, since the serum is almost certain to become infected.

This transpleural method of operating can be performed with only a slight narcosis, or, if need be, under the influence of a local anæsthetic. It must be admitted that one cannot always protect a healthy pleura from infection by this method of operating. However, in a majority of cases the pleura will be found infected at the time of operation.

The other method of operating is to make an incision along the costal margin and follow this with a blunt dissection along the under surface of the diaphragm until the abscess is opened. This method is to be recommended for abscesses situated behind the liver. Some surgeons resect the lower ribs when operating by this method, although it entails a risk of infecting the pleural cavity. Subphrenic abscess from the appendix, spleen, and kidney is suited to this method of treatment.

If a subphrenic abscess derived from the stomach or duodenum lies well forward, it can be opened by an incision in the median line from the ensiform process downward. The perforation in the stomach is usually so hidden by adhesions that it is not accessible. If the abscess cavity is very large and extends well backward, a counteropening should be made on the left side by traversing the pleura or beneath the twelfth rib. The cavity of the subphrenic abscess rapidly decreases in size after it has been drained and is completely closed by granulations in six or eight weeks, or in even less time in favorable cases.

Prognosis.—The prognosis of subphrenic abscess after operation depends upon the general condition of the patient, the size of the abscess, the source of the trouble, and any complications which may exist. Therefore the prognosis is much more favorable if an abscess is opened early. Körte operated upon 60 cases of subphrenic abscess, with 40 recoveries and 20 deaths, a mortality 33.3 per cent. The origin of the abscess in these cases was as follows:

Source of abscess.	No. of cases.	Recoveries.	Deaths.
Appendicitis	27	18	9
Stomach	9	5	4
Duodenum	1	—	1
Spleen	5	3	2
Perirenal	4	2	2
Liver and gall-bladder	2	2	—
Pleural	4	3	1
Costal	2	2	—
Pancreas	1	1	—
Ecchinococcus	3	3	—
Undetermined	2	1	1
Total	60	40	20

Maydl's statistics include records of 10 operations upon abscesses of gastric origin with 3 recoveries; 14 of pericæcal origin with 9 recoveries; 5 of hepatic origin with 4 recoveries; 4 of intestinal origin with no recoveries. Altogether operation was performed in 74 cases of subphrenic abscess, with 39 recoveries and 35 deaths, a mortality of 47.2.

Chronic Peritonitis.—A chronic inflammation of the peritoneum may follow an acute inflammation, or the inflammation may be chronic from the beginning, and in the form of an exudative or an adhesive peritonitis.

Exudative Chronic Peritonitis.—Chronic inflammation of the peritoneum with the formation of an abundant fluid exudate is so closely allied in form to tuberculous peritonitis that a microscopical examination may be necessary to determine which exists. The attacks of simple chronic peritonitis which have been described by Vierordt, Galvagni, Fränkel, and others, terminated for the most part in recovery, so that the certainty of diagnosis which might have followed an autopsy is wanting. It is fair, however, to assume that all such cases are not tuberculous because simultaneous affection of the pleura and bronchial tubes makes it more than probable that some of these inflammations are of a tuberculous character.

The etiology of simple chronic peritonitis is uncertain. Sometimes it has been ascribed to taking cold and at other times to traumatism. It is not even possible to say whether the affection of the peritoneum is primary or whether it is secondary to that of some abdominal organ.

The disease is more common in young persons than in those of adult life, and is more common in females than in males. This suggests the possibility of its development from the female genitals. Indeed, its appearance at the time of menstruation has been noted. Its onset is gradual, the first symptoms noted being usually the presence of a serous exudate which gradually increases in quantity until its amount may be very great. Sometimes the collection of fluid gives rise to no pain. At other times there is pain, either spontaneous or produced by pressure. If the quantity of fluid is large, it may press upon the abdominal organs and interfere with their functions. This is especially true in regard to the intestine. Sometimes firm, pebbly tumors have been observed in the region of the umbilicus. In about half of the cases there is fever. The general health is almost always affected. The patient is pale, weak, and loses weight. The condition is frequently complicated by pleurisy.

Diagnosis.—The diagnosis rests upon the history and progress of the disease as well as upon the physical signs, especially the fluid and the existence of nodular tumors. The differential diagnosis with tuberculous peritonitis may be made by injection of tuberculin or the injection of the exudate into animals, otherwise a differential diagnosis cannot be made before operation. Other diseases which should be considered are ascites due to cirrhosis of the liver or to diffuse congestion, and carcinomatous peritonitis.

Prognosis.—The prognosis is favorable, since a majority of patients recover under the influence of internal remedies, inunction of mercurial salve, or hydropathic treatment.

Treatment.—On account of this favorable prognosis surgical treatment is not indicated unless the exudate is so great as to interfere with the functions of the abdominal organs. In that case the patient should be relieved by tapping. If the diagnosis between simple peritonitis and tuberculous peritonitis is not clear, it is better to open the abdomen, since an exploratory laparotomy will not injure a patient having a simple chronic peritonitis, while the good effect of this treatment upon tuberculous peritonitis is well known. Exploratory laparotomy frequently hastens recovery from a simple peritonitis. The operation should be confined to removal of the fluid and inspection of the abdominal cavity. Lennander recommends that the abdominal cavity be irrigated, and that if the peritonitis is not cured by one irrigation, that it should be repeated several times if necessary.

Adhesive Chronic Peritonitis.—The second form of chronic peritonitis is associated with the formation of adhesions and cicatricial contractions of the peritoneal folds. This form of inflammation may affect one or more portions of the abdominal cavity. It is most likely to occur in the neighborhood of the female pelvic organs, the gall-bladder, a flexure of the colon, the root of the mesentery, or the omentum. The effect of the inflammation is thickening of the peritoneum, which later leads to contraction. Such contraction of the mesentery has been held to favor the development of volvulus, although this view has been disputed by Riedel. Adhesions which may form between movable abdominal organs interfere very much with their function, and, indeed, may threaten life by obstructing the intestine. Chronic adhesive peritonitis may follow acute inflammation in some abdominal organ. It may also follow injury or a laparotomy. But it may also develop in a chronic manner without such predisposing cause, or, indeed, without any apparent cause. In most cases, however, it is a secondary manifestation of obscure inflammation of some portion of the alimentary canal. Fecal obstruction, the traumatic irritation to which a hernia is subjected, and the lesions of syphilis in some abdominal organ, have all been mentioned as causes of chronic peritonitis.

Symptoms.—The symptoms of chronic adhesive peritonitis vary according to the extent and situation of the trouble. They are usually well localized. Thus, adhesions in the neighborhood of the gall-bladder and pylorus will produce intense colicky pains if they are of such a character as to interfere with the normal passage of food and bile. Adhesions of the omentum to the intestine or to the anterior abdominal wall may give rise to intense intestinal colic. Chronic inflammation of the peritoneum of the pelvis often leads to displacement and disturbance of function of the pelvic organs. Adhesions about the cæcum or hepatic or splenic or sigmoid flexure may seriously interfere with the function of the large intestine and produce chronic constipation.

Treatment.—Surgical treatment may be demanded either because of the degree to which chronic adhesions interfere with the natural functions or because they have produced some acute condition, such as volvulus or other obstruction of the intestine, which threatens the patient's life. Riedel strongly advocates operation as a cure of this trouble. If division of the bands and separation of the adhesions have no permanent good result, he believes in removing the starting-point of the inflammation if this is possible. Thus, the points of attachment at either end of the fibrous cord may be excised. If the adherent surfaces are extensive, they cannot be treated in this manner unless the diseased organ is the appendix or gall-bladder or Fallopian tube, or some other abdominal organ whose presence may be dispensed with. Still, encouragement is found for operation in the fact that adhesions which normally form after every laparotomy disappear in the course of time. Thus if one can so free the distorted adherent intestine that its function will be restored and congestion avoided, it is reasonable to hope that it will in time cause disappearance of the adhesions of chronic peritonitis.

Tuberculous Peritonitis.—Tuberculosis of the peritoneum appears in two forms: either as miliary tuberculosis, in which case it is a part of a general miliary tuberculosis, and therefore gives no special symptoms and requires no special treatment; or it appears as a tuberculous inflammation of the serosa. In the latter case the peritoneum is swollen and its vessels injected; its smooth surface becomes rough and covered with numerous grayish nodules which tend to coalesce and form larger nodules. The process is usually accompanied by an exudate, which may be fibrinous, seropurulent, or hemorrhagic, or a combination of these different kinds.

For clinical purposes it is convenient to divide tuberculous peritonitis into three forms: (1) that which is associated with an abundant serous exudate; (2) that which is accompanied by adhesions and large nodular tumors in the omentum and mesentery; and (3) an ulcerative purulent form in which intestinal coils and omentum are crowded together in an indistinguishable mass in which are pockets having caseous and purulent contents. The dividing-line between these different forms is not a sharp one, but one may pass into the other or different lesions may coexist.

Tuberculosis of the peritoneum is rarely a primary disease. Borschke, who examined 226 cases, found only 2 in which there was no starting-point for the disease outside of the peritoneum. The lungs were the seat of the primary lesion in 200 of these 226 cases, while in the remaining cases the disease began in other serous membranes, such as the pleura or peritoneum, or in the intestine, or in the lymph-glands or bones or joints. The tubercle bacilli may reach the peritoneum through the bloodvessels or lymph-vessels, or by direct extension from some organ which is covered with peritoneum. The previous existence of cirrhosis of the liver has been mentioned, but no connection between the two diseases has been shown. The serous exudate is

usually sterile, and tubercle bacilli are found in it with difficulty. The best test is to inject the serum into a guinea-pig.

Symptoms.—The disease affects children especially, and also young persons. It runs a chronic course, being aggravated from time to time by acuter attacks. The chief symptom noticed is a progressive cachexia. The temperature may be elevated. The pulse and respiration are unfavorably affected by the distention of the abdomen. There are rarely symptoms directly attributable to an inflammation of the peritoneum. Sometimes the patient complains of abdominal pains, but these are never so severe as those which are present in acute peritonitis, unless the tuberculous process has obstructed the intestine. Tenderness on pressure is usually slight. Vomiting is not a prominent symptom, and when it does occur it has not the stormy character of vomiting which accompanies acute peritonitis. The function of the intestine may be disturbed by contraction of the mesentery, or by adhesions, so that obstruction may even be complete. In most cases, however, the intestine is not paralyzed or dilated.

The symptoms of the disease are due to a gradually increasing quantity of fluid in the peritoneal cavity. This accumulation of fluid may continue until the abdominal walls are tightly stretched and respiration and blood circulation are much interfered with. Sometimes the abdominal fluid is confined by adhesions. This encapsulation of the fluid simulates a cystic tumor, so that a mistake in diagnosis has frequently been made. The nodular masses spoken of are usually formed of the omentum or mesenteric glands. If disease of some intra-abdominal organ coexists—for example, the intestine or female genital organs—symptoms due to such disease may obscure those due to the tuberculous peritonitis.

Tuberculosis of the cæcum and vermiform appendix leads to the formation of a tumor which may be mistaken for a simple chronic appendicitis or for a malignant growth. It may bring about stenosis of the intestine with the well-known symptoms. Tuberculosis of the tubes gives symptoms similar to these of perimetritis. Rupture of a tuberculous ulcer may bring about purulent inflammation which may be either diffuse or circumscribed.

Diagnosis.—The diagnosis of tuberculous peritonitis can be made from the symptoms above described of a disease running a chronic or subacute course, gradual loss of strength, the presence of free or encapsulated exudate, or nodular tumors in different portions of the abdomen. The diagnosis is confirmed by the presence of tuberculosis of the lungs or some other organ. Chronic peritonitis of a non-tuberculous character cannot be distinguished clinically from tuberculous peritonitis. Some writers assert that the so-called idiopathic chronic peritonitis of a non-tuberculous character does not exist. The injection of tuberculin may be of assistance in determining the nature of a chronic peritonitis. It should be remembered that this test is not wholly without risk, especially in cases of intestinal tuberculosis. The

injection of guinea-pigs with the exudate is another means of diagnosis which has sometimes proved valuable. In other cases it is difficult to decide between sarcomatous and tuberculous peritonitis. The age of the patient and the presence of malignant tumor in the abdomen or elsewhere, and the reaction which follows the injection of tuberculin will assist in making the diagnosis in such cases. In doubtful cases an exploratory laparotomy is justifiable. Helbing mentions a case of chronic peritonitis resembling tuberculous peritonitis which was produced by the eggs of a tapeworm. Cirrhosis of the liver with ascites may simulate tuberculous peritonitis. Under such circumstances there may be a history of abuse of alcoholic drinks, swelling of the spleen, and jaundice.

Treatment.—For a long time it was considered that peritoneal tuberculosis could be treated only medicinally and the outlook was very unfavorable. Forty years ago Spencer Wells unintentionally operated upon a patient with tuberculous peritonitis who made a prompt recovery. Since that time many such patients have been treated by operation, usually with good results in the serous form of disease, and with passably good results in the dry form. The results in the ulcerative form are unfavorable. The ultimate results are not so favorable as the immediate results. Borchgrevink and Rose have both examined the results of treatment in the past ten years, and both come to the conclusion that about one-third of all cases of peritoneal tuberculosis will recover spontaneously or without operative treatment, and that operation upon patients who are suffering from tuberculous peritonitis with fever may be extremely harmful.

Treatment by operation is simple. The abdomen is opened in the median line with the usual aseptic precautions, care being taken not to wound adherent intestine. The fluid exudate is allowed to flow out and the rest of it is sponged out until the peritoneal cavity is quite dry. Some surgeons dust the peritoneum with iodoform. The abdominal wound is closed in layers, with or without iodoform gauze drainage. The reaction is slight. There is often some reaccumulation of fluid soon after the operation. This is usually resorbed, so that a second operation is rarely necessary. Sometimes operation is followed by the formation of tuberculous fistulas. Löhlein advises opening a tuberculous peritoneal cavity in females through Douglas's pouch.

Operation in ulcerative tuberculous peritonitis is likely to be followed by intestinal fistulas which exhaust the patient and hasten his death. Other counterindications for operation are: advanced tuberculosis or amyloid changes in the lungs, intestine, or kidneys, which will either prevent recovery from the operation or make it likely that the condition of the patient can be improved for only a short time.

If the surgeon finds well-localized tuberculous lesions in the abdomen—for example, in the cæcum or appendix or Fallopian tubes—it may be possible to remove them without taxing the strength of the patient too much. Such an operation as resection of the intestine had better

be postponed until the patient has gained strength and has at least partly recovered from the tuberculous peritonitis. If adhesions obstruct the intestines, so that some operation is urgently demanded, it should be of the simplest character—for example, an entero-anastomosis. The serosa which is affected by tuberculous inflammation is easily torn, and is therefore stitched with difficulty. One should not disturb extensive adhesions, since they are very vascular, and in attempting to separate the adherent intestinal coils the bowel is easily torn.

The exact method by which operation benefits a patient having tuberculous peritonitis is a matter of dispute. It seems probable, however, that the evacuation of the exudate by relieving the tension of the abdominal wall and the irritation of the serosa brings about improvement in the circulation of the serosa so that the leucocytes are able to attack the tubercle bacilli in greater numbers. Borchgrevink states that these same processes may take place without operation, and hence is inclined to deny that any good effect is due to the operation itself. Gatti believes that the fluid exudate which follows operation exerts an injurious effect upon the tubercle bacilli and thus promotes recovery.

Prognosis.—The immediate results of operation except in cases of the ulcerative form of the disease are good. The later results are less favorable, since a certain number of patients die from recurrence or from tuberculosis in other organs. Thus Rörsch collected reports of 358 cases, showing 70 per cent. of immediate cures and 14.8 per cent. of cures lasting more than two years. Wunderlich, who collected reports of 344 cases, found 23.6 per cent. of deaths and 23.3 per cent. of cures over three years. These are general statistics; the results of individual surgeons are somewhat better. Thus in Czerny's clinic from 40 to 50 per cent. of patients suffering from the exudative form of the disease were cured by operation, while only 25 per cent. of those who suffered from adhesive tuberculous peritonitis were cured. The best results were obtained in cases of tuberculous peritonitis proceeding from the adnexa when these affected organs could be removed at the operation.

The relative advantages of operative and non-operative treatment can only be determined when a large number of patients have been treated by both means under similar conditions so that results can be compared. If the views of Borchgrevink and Rose are correct, operation is indicated only in cases of exudative or adhesive tuberculous peritonitis after a patient has been given the advantages of internal treatment combined with good food and fresh air for a considerable period without improvement. All writers are agreed that operation cannot benefit a patient who suffers from the ulcerative form of the disease.

ACTINOMYCOSIS OF THE PERITONEUM.

In actinomycosis of the intestine the fungus may pass from the intestine into the peritoneal cavity or into the subserous tissue. The cæcum is the usual starting-point of this trouble. As a result there develop numerous hard tumors which are neither tender nor movable, and a fibrous exudate which causes adhesions between the omentum and intestine. Within this granular tissue will be found the characteristic yellow pearly bodies. As time goes on, suppuration takes place within the swelling. The pus may discharge itself externally or lead to the formation of tortuous fistulas between the intestinal coils, with ultimate rupture into the intestine or bladder.

Diagnosis.—Diagnosis will rest upon the presence of circumscribed hard indolent nodules which exist without fever and without pain. Diagnosis will be certain when the characteristic pearls are found in the pus.

Treatment.—Soft places should be incised and the diseased tissue curetted and cauterized. Potassium iodide may be given internally and a solution of the iodide used to irrigate the fistula. A weak solution of mercuric chloride may be injected into the inflammatory masses. If the process is extensive, so as to involve large areas both within and without the peritoneum, the resulting suppuration and formation of fistulas may exhaust the patient so that death follows.

TUMORS OF THE PERITONEUM, OMENTUM, AND MESENTERY.

Carcinoma.—Gelatinous carcinoma, endothelioma, and angiosarcoma occur as rare primary tumors of the peritoneum. Not infrequently malignant tumors of the abdominal organs involve the serosa in the form of numerous small nodules scattered over its surface, with larger nodules in the omentum and mesentery. Such a condition is almost always accompanied by an abundant fluid exudate of a serous or hemorrhagic character which contains many fatty degenerated and carcinomatous cells. It is not possible to differentiate primary and secondary carcinoma of the peritoneum by clinical signs.

The presence of fluid in the peritoneal cavity and the nodular tumors above spoken of are the general signs of carcinoma of the peritoneum. Symptoms due to inflammation are slight, and are quite overshadowed by symptoms referable to the organ which contains the primary growth. If the growth of a cancer leads to perforation of a hollow organ, there will be an acute, rapidly fatal perforative peritonitis. Without such an accident the general condition of a patient whose peritoneum is carcinomatous is similar to that of a patient whose peritoneum is tuberculous. If the patient is of mature years, the trouble is more likely to be carcinomatous, but this inference is not always a reliable one, since cancer of the intestine (usually sarcoma) occurs at an early age.

Treatment.—Treatment is purely symptomatic. If the exudate

causes great pain, it should be reduced by puncture; but the relief thus obtained is usually of short duration.

Benign Solid Tumors.—Fibroma, lipoma, myxoma, and similar tumors usually grow from the subserous tissue, and may reach a large size. For the most part they develop in the root of the mesentery, the mesocolon, or the omentum. Such a tumor grows slowly and causes symptoms simply by traction or pressure upon neighboring organs. It is firm with a smooth surface, lying behind the coils of intestine and only slightly movable from side to side. A tumor of the omentum is an exception. It is situated in the region of the umbilicus immediately beneath the anterior abdominal wall and is movable. When such a tumor reaches a certain point in its development, it drags upon the stomach and causes intense pain.

Retroperitoneal and mesenteric lipomata have often been successfully removed. A free incision is made in the median line and the posterior layer of peritoneum which covers the tumor is divided and its vessels ligated. The tumor is next shelled out by blunt dissection. As one approaches the base of the tumor in the region of the mesentery the risk of hemorrhage from ill-developed thin-walled vessels is great. The retroperitoneal wound should be thoroughly dried and closed by suture. The intestine should be examined to see if the blood-supply has been cut off from any portion of it. Should this be the case, that portion must be resected. If a retroperitoneal tumor is situated to one side of the spine, it may be removed through a lumbar incision without opening the peritoneum.

In removing a solid tumor of the omentum it is important to avoid wounding the transverse colon, with which the tumor is often closely associated. Sometimes a tumor which starts from the stomach or transverse colon extends between the layers of the omentum, but such a tumor is not an omental tumor.

The omentum is sometimes the seat of an inflammatory tumor after operations for hernia and inflammation of the appendix, or other operations upon the abdomen. Such a tumor is an inflammatory swelling of the omentum, the immediate cause of which is the ligation of masses of the omentum to control hemorrhage. Such a swelling may cause so much pain for weeks or months after the operation that the diagnosis of a malignant new growth has more than once been made. Sometimes an abscess develops with the usual symptoms, germs coming from the ligatures or being introduced at the time of operation. Such an inflammatory tumor subsides in time under the influence of rest unless it goes on to suppuration. In the latter case it attaches itself to the abdominal wall, when the pus may be evacuated through an incision which does not open the peritoneum.

Torsion of the omentum is of rare occurrence. It usually occurs in connection with hernia, in the course of which the omentum has been matted together, while its attachment to the intestine has been stretched out to a slender pedicle. When these changes have taken place, the omentum may be twisted by external influences until the

vessels of the pedicle are obstructed and a hemorrhagic infarct is the result. This accident will produce a serohemorrhagic exudate and symptoms of peritoneal irritation and intestinal paralysis. The abdomen should be opened and the omentum resected.

Ligation of the omentum is sometimes followed by embolism of the liver or stomach.

Benign Cystic Tumors.—Secondary echinococcus cysts are found in the peritoneal cavity, due presumably to rupture of a traumatic cyst. Their favorite seat is the omentum. Primary echinococcus of the omentum or mesentery is rare.

Cysts of the mesentery are divided by Hahn into serous cysts, chyle-cysts, and blood-cysts. All of these form rounded, tense, freely movable tumors at the umbilicus. Such a tumor may reach the pelvis and become attached to the uterus. The intestine either circles around the cyst or lies in front of it. A similar relation of the colon to a cyst of the mesocolon may be demonstrated by distending the intestine with air. A cyst of the mesentery often causes intense pain, presumably due to pressure upon the mesenteric nerves. It may press upon the intestine and more or less completely obstruct the fecal flow. Cystic tumors of the mesentery have in some instances followed traumatism.

Cysts of the omentum give almost the same symptoms as cysts of the mesentery. Consequently a differential diagnosis is impossible. It is impossible to tell except by puncture the nature of the contents of the cyst. Such puncture is not without danger, since the intestine may lie in front of the cyst. In operating upon such a cyst it is important to split the peritoneum which covers it in such a manner as not to injure the vessels. It may be possible to shell out the cyst by a blunt dissection, or, if this cannot be done without risk of injuring important vessels or the intestine, it is better to remove as much of the cyst-wall as possible and to stitch the remains of the cyst in the abdominal wound. As these cysts are not lined with epithelium perfect recovery may follow this treatment.

An epithelial cyst sometimes develops in the mesentery from the remains of the omphalomesenteric duct. A cyst of this character must be removed entirely, otherwise a fistula will persist.

If an echinococcus cyst cannot be easily removed, it should be sutured in the wound and drained.

Remains of the Wolffian and Müllerian ducts may develop into cysts of the retroperitoneal tissue which can be removed through a lumbar incision without opening the peritoneum.

Teratoma of the Peritoneum.—Lexer, who has made a special study of teratomata of the peritoneum, divides them into simple and complex dermoids, fœtal inclusions, and teratoid mucous tumors. Simple dermoids spring from the abdominal cleft and are usually situated in the omentum or mesentery; or if they come from the Wolffian ducts, they are situated retroperitoneally in the loin. Complex dermoids spring from the ovaries or misplaced testicles and are found

in the pelvic region. Fœtal inclusions come from an undeveloped twin and are usually situated between the layers of the transverse mesocolon or in the bursa epiploica. In other cases they have been found in the mesentery or in the retroperitoneal tissue. Teratoid mucous tumors are either solid or polycystic and contain tissue from all three embryonic layers. They are in most cases the result of bigeminal implantation.

ASCITES.

A collection of serous fluid in a peritoneal cavity not accompanied by inflammation is called ascites. It is due either to general venous obstruction a result of cardiac or pulmonary disease, or to local obstruction of the portal system resulting from thrombosis or cirrhosis of the liver or disease of the spleen. A third cause is general hydræmia the result of renal disease or other cachexia.

The fluid in ascites is usually a clear serum. If it is mixed with blood, it is probably due to carcinoma, tuberculosis, or traumatism. Sometimes the serum contains fatty degenerated cells or leucocytes or free fat-drops, giving it a milky appearance. The condition is then spoken of as chylous ascites. Chyle may enter the peritoneal cavity from ruptured lacteals or when the flow in them is obstructed by the pressure of tumors or by thrombosis or bacteria. The exudate in carcinoma of the peritoneum may also have a milky character on account of the presence of numerous fatty degenerated tumor-cells.

Symptoms.—The presence of free fluid in the abdominal cavity is manifested by dulness on percussion ovor the most dependent portion of the abdomen, a dulness which changes its position with changes in the position of the patient. Furthermore, tapping upon the abdominal wall will usually give a distinct wave of fluctuation. These signs are not often obtained unless the quantity of fluid exceeds one-half litre (quart). The fluid in ascites contains a small amount of albumin (1 to 3 per cent.), while the serous exudate in peritonitis contains from 3 to 5 per cent. The diagnosis is strengthened by proof of the existence of a disease which may cause ascites.

Treatment.—Ascites should be treated by suitable internal remedies. If these fail, puncture is a valuable palliative measure which must often be repeated many times. Operation has recently been recommended for certain forms of ascites, especially for that due to cirrhosis of the liver.

Operative treatment was suggested by Drummond and Morrison in 1896 and by Talma in 1898. The principle of operation is to establish a collateral circulation between the visceral peritoneum of the omentum, liver, and spleen and the parietal peritoneum in order to relieve the portal congestion. With this idea in mind a number of surgeons have operated with a certain measure of success. These adhesions may be set up in a variety of ways: by suture, by tamponade, by stretching or by rubbing the opposed peritoneal surfaces, etc.

Further experience is necessary in order to demonstrate the utility of such operations.

Puncture for ascites should be an aseptic operation. The skin of the abdomen should be disinfected and the trocar boiled. The instrument may be inserted in the linea alba below the umbilicus, the bladder being previously emptied, or in either side in the lower portion of the abdomen, or half-way between the umbilicus and the anterior spine of the ilium. The objection to the last-named situation is the risk of wounding the epigastric artery which runs in the sheath of the rectus muscle. If the recti are widely separated by the increased intra-abdominal pressure, these vessels may be displaced outward; therefore it is better to puncture at a point plainly beyond the outer margin of the rectus muscle. . The trocar should be plunged quickly through the abdominal wall. As soon as the point of the trocar enters the fluid the operator's hand will recognize the absence of resistance. It is scarcely possible to injure the intestine by this manœuvre unless one punctures at a spot where intestine is adherent or there is no free fluid. The ascitic fluid should not be drawn off too rapidly lest the resulting distention of the abdominal vessels produce a cerebral anæmia. If a loop of intestine or omentum floats against the inner end of the canula, the flow of fluid will cease. Such obstruction can be overcome by moving the canula from side to side or by thrusting an aseptic probe through it. It is never possible to remove all the ascitic fluid. It is best for the patient to be half-reclining, leaning backward or to one side. If he is sitting upright, he may easily become faint. The little wound may be closed with a bit of gauze and adhesive plaster. Sometimes puncture is followed by a serous drainage, especially if the abdominal wall itself is œdematous.

In the rare cases in which the epigastric artery is punctured blood will flow from the wound in a stream after the removal of the canula, or there will be signs of internal hemorrhage—anæmia, faintness, a small rapid pulse, and vomiting. The hemorrhage may be controlled by pressure of the wound against the ilium; or, if the abdominal wall is much relaxed, a fold of it may be compressed between the fingers. If no assistance is at hand, this compression may be kept up until the hemorrhage stops. The hemorrhage can be readily controlled by passing a curved needle and thread beneath the vessels and tying it over a pad of gauze; or, if this fails, the wound of puncture should be incised, and the vessels exposed and ligated.

It is often necessary to repeat this operation of tapping for ascites many times. A result which occasionally follows is a chronic inflammation of the peritoneum with hemorrhagic exudate.

CHAPTER XI.

LAPAROTOMY.

By Prof. J. v. MIKULICZ and Dr. W. KAUSCH.

PREPARATION OF THE PATIENT.

Every patient upon whom laparotomy is to be performed should be examined from head to foot. Even the simplest laparotomy should be looked upon as an operation of great importance, and the resisting power of the patient should therefore be fully investigated. When time permits, his manner of living should be so regulated that his general health will be as good as possible. The individual resistance plays an important part in treatment by laparotomy. Feeble, aged, emaciated, and ill-nourished persons, as well as individuals with pulmonary and cardiac diseases, often fail to recover from an operation which would be easily borne by a person in robust health. A weakened individual is less able to resist bacterial attack, and he also suffers more from shock, from exhaustion, and from pneumonic processes. Any recent catarrh of the respiratory passages increases the risk of pneumonia after operation. Hence under such circumstances one should postpone the laparotomy if the delay is not dangerous for the patient. The examination of the patient should, of course, include the examination of his urine, preferably the twenty-four hour urine.

Except in cases of peritonitis, the patient should be given a full bath, preferably on the day before operation. The stomach, intestinal canal, and bladder should be thoroughly emptied. If these organs are full, palpation and inspection of the peritoneal cavity and most operative procedures are rendered more difficult. The patient should therefore take nothing by the mouth for some hours previous to operation, and if there is reason to suppose that the stomach is not empty it is better to wash it out. Irrigation of the stomach is advisable in all cases of ileus and of marked insufficiency of the stomach. If the stomach itself is to be operated upon and no counterindication exists, such as fresh hemorrhage, it should be irrigated with sterile water until the fluid returns clear.

The intestine can best be emptied by giving the patient mild laxatives for two or three days before the operation (castor oil, Carlsbad salt, etc.). The strength of these laxatives should be the greatest when the large intestine is to be operated upon. During this period of preparation the patient should receive only a fluid diet. On the evening

before the operation the lower bowel should be thoroughly cleansed by high enema. To extend this period of preparation, as some surgeons do, over one week or even two weeks is inadvisable, as little or nothing is gained thereby and most patients are much weakened by a prolonged fast. The effect of fasting upon the number of bacteria in the stomach and intestine is shown by the accompanying diagrams, Figs. 55 and 56.

FIG. 55.

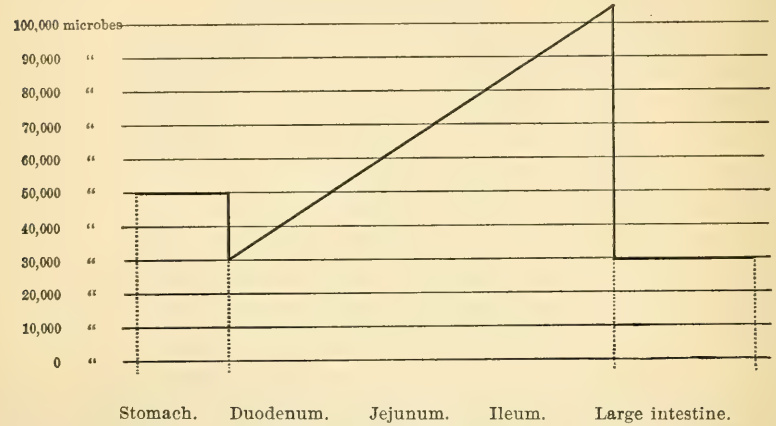


Diagram of Gilbert and Dominici, showing the relative number of micro-organisms in the dog's intestine two or three hours after a meal. (Société de Biologie, séance du 19 février, 1894.)

FIG. 56.

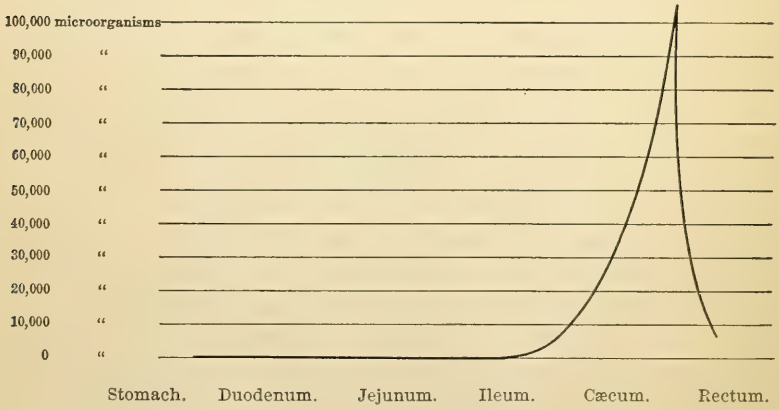


Diagram showing the relative number of micro-organisms at different levels of a dog's intestine after a prolonged fast.

If the bladder cannot be emptied voluntarily, it should be catheterized, especially if an operation is to be performed upon the organs in the lower portion of the abdomen. If this is not done, the bladder may be injured by the first incision before the peritoneal cavity is opened.

If the patient is much emaciated, as, for example, a patient with stricture of the œsophagus or of the pylorus, it is often advisable to give him a subcutaneous or intravenous injection of not more than one litre of salt solution. A rectal injection just before operation is harmful since it stimulates peristaltic action.

In most cases of laparotomy the patient can best be operated upon in a horizontal position. If operation is to be performed upon some pelvic organ, it is of advantage to elevate the pelvis. When the operation has been completed, the patient can be placed in a horizontal position so that the abdominal organs will resume their normal relations before the abdominal wound is sutured. If the operation concerns the epigastric region, it is of advantage to elevate the shoulders of the patient so as to relax the recti muscles and to avoid pressure from the organs of the lower abdomen. If the peritoneal cavity is to be opened through the vagina, a lithotomy position is desirable. The patient is usually placed upon his side if the peritoneal cavity is to be opened in the lumbar region or parasacral region, or through the thorax.

The operator usually stands at the right side of the patient, although if the left side is to be operated upon he may prefer to stand on that side. If the patient lies upon his side, the operator usually stands at his back. Some operators prefer to sit or stand between the thighs of the patient, whose pelvis is elevated for the laparotomy.

The room in which the patient is prepared for operation as well as the room chosen for the operation should be heated to about 20° to 24° C. (68° to 76° F.) and the patient should be warmly clothed. The operating-table should also be warmed. If a patient is much emaciated, he may be wrapped in cotton. The cooling which follows eventration of large portions of the intestine or other organs may have a serious effect. This should be limited by wrapping the exposed organs in cloths wrung out of a sterile hot 1 per cent. saline solution. It is beyond doubt that many patients "take cold" as the result of a loss of bodily temperature during the preparation for operation or during the operation itself. Carelessness in this regard is certainly responsible for many cases of post-operative pneumonia. Since particular attention has been given this matter in the Breslau clinic the number of post-operative pneumonia cases has markedly decreased.

The preparation of the operation-room for a laparotomy as well as the preparation of the field of operation, the hands of the surgeon, etc., are governed by the usual rules for surgical operations. In this chapter it is only necessary to give such rules as are especially important for laparotomy. The field for operation should be disinfected for a considerable distance, since one never knows how extensive the incision must be, or whether a second incision will be required, therefore the abdomen should be shaved and disinfected from the breasts to the symphysis and from one posterior axillary line to the other. Particular attention should be given to disinfection of the pubic region even though the wound is so far removed as the epigastrium. If the abdominal skin is eczematous, or if for any other reason it cannot

be thoroughly disinfected, Mosetig recommends that a piece of batiste in which a cut of suitable length has been made should be placed over the wound as soon as the skin has been incised. The edges of the cut in the batiste are then clamped to the edges of the skin by peritoneal clamps (Fig. 57, page 209) and the wound is thus protected from cutaneous infection.

In simple cases one assistant is sufficient. If complication exists, a second one is a great help. It is also necessary to have one or two persons to hand instruments and sponges, although some operators prefer to reach for these things themselves in order to lessen the possibility of infection. This seems a poor arrangement in most cases, for it prolongs the operation considerably, and if the additional assistants are suitably trained, the risk of infection is not worth considering if operators and assistants wear sterilized gloves. Moreover, sponges may be passed to the operator with sterilized forceps instead of the fingers. The use of woven gloves, aside from the fact that they protect the patient from infection, is very advantageous in abdominal operations since they give the operator a firm grasp upon the intestine and other peritoneal surfaces and thus facilitate a gastric or intestinal suture, the tying of ligatures, etc.

Ether is better than chloroform for general narcosis since it does not decrease the blood-pressure as does chloroform. The relative advantages of local and general anæsthesia depend upon a number of circumstances. The retention of consciousness during a serious operation is a disadvantage for many patients. It is possible to anæsthetize the anterior abdominal wall, the parietal peritoneum, and also the abdominal organs by a local anæsthesia. The parietal peritoneum, as shown clinically and by laparotomy experiments, is the most sensitive part of the peritoneal cavity. The visceral peritoneum is often wholly insensitive unless it is inflamed. When inflamed, and particularly in the case of the stomach, it is extremely sensitive. Traction upon peritoneal folds, such as the mesentery, mesocolon, or omentum, is extremely unpleasant for the patient and produces a strikingly bad effect upon the action of the heart, or even a collapse which combined with the shock of the operation may prove fatal. The abdominal organs themselves are for the most part insensitive. Local anæsthesia does not relax the abdominal walls as general anæsthesia does. The pneumonia which sometimes follows laparotomy, and which was previously attributed to inspiration of mucus, etc., during unconsciousness, may also follow a laparotomy in which local anæsthesia is employed. Local anæsthesia is far less dangerous than general anæsthesia in those cases in which it is impossible to empty the stomach—for example, in ileus with constant fecal vomiting. Under such circumstances it is practically impossible to prevent the vomited material from entering the bronchi. Even the introduction of a stomach-tube or elevation of the pelvis will not surely prevent this accident.

In accordance with the principles given in the preceding paragraph most surgeons employ local anæsthesia for laparotomy only in those

cases in which the operation bids fair to be of short duration and easily carried out; for example, in the case of gastrostomy or colostomy, or for operations upon hernia. A general narcosis is far preferable in serious operations, especially those in which the abdominal organs must be handled and pulled upon. If the condition of the patient makes it necessary to give him the smallest quantity of ether, the treatment should be as follows: subcutaneous injection of morphine, 0.01 gramme ($\frac{1}{6}$ grain), local anæsthesia for the abdominal incision, and then a light general anæsthesia secured by continuous dropping of ether upon the cone, which is to be stopped as soon as the painful manipulations of the peritoneum are finished.

Tuffier and some other surgeons employ spinal anæsthesia in the case of laparotomy upon the lower abdominal organs, but Mikulicz and many others are dissatisfied with the results obtained by this method.

THE ABDOMINAL INCISION.

Choice of Incision.—The peritoneal cavity can be opened in a number of places. Incisions used in laparotomy are therefore divided into anterior (median or extramedian), lateral, posterior (lumbar or parasacral), vaginal (perineal), and thoracic. The object of the incision is (1) to give the operator access and a view of the parts to be operated upon, (2) to enable him to avoid injury to other organs, and (3) to enable him to preserve the anatomical relations of the abdominal walls, so that recovery shall be followed by a firm scar.

The first object generally requires an incision close to the part to be operated upon. In many cases there is little choice of incision, as in operating for a hernia or an adherent tumor or abscess. In other cases in which the trouble is in the central part of the abdomen, or a movable tumor is to be removed, or an exact diagnosis cannot be made, the surgeon can choose his incision, and the one chosen under such circumstances is generally in the region of the umbilicus. Through such an incision one can examine the whole abdomen, and if necessary reach any of the abdominal organs.

The course of bloodvessels, such as the epigastric artery, need not influence one in making the incision, but the situation of muscles and nerves has often to be considered. Some surgeons prefer to make an incision anywhere except through the fibres of a muscle—for example, in the median line or at the outer edge of the rectus muscle; or close to the margin of the ribs or the crest of the ilium. Others prefer to make the incision through a muscle, believing that they will obtain a firmer scar by this means. In accordance with this view they make an incision to one side of the linea alba rather than through it. Some operators separate the muscle-fibres longitudinally, and others prefer to cut square across them, each believing that his favorite method yields the firmest scar.

Every incision through the abdominal wall, with the exception of one in the median line, injures some nerves. While division of sensory

nerves is of no importance, division of motor nerves is followed by paralysis of some muscle-fibres which is usually permanent. The effect of this is to favor the development of ventral hernia, as is shown by experiments upon animals (Asmy) and also by clinical observation. The more closely the incision parallels the course of the nerve-fibres the fewer of them will be divided. The nerves under discussion are the intercostal, the iliohypogastric, and the ilio-inguinal. The practical conclusion is that a lateral incision should extend from above downward and forward, and should be more nearly transverse than longitudinal. Many surgeons attempt to save the nerves by making a blunt dissection. Such an attempt is only successful in the case of short incisions, for if the dissection is a long one, the nerves are almost certain to be torn.

How to operate so as surely to avoid a subsequent ventral hernia is a question which is not yet satisfactorily answered. Methods of suturing are discussed elsewhere in this chapter. It is certain that an incision in the median line is rarely followed by a hernia if it can be firmly sutured and heals aseptically. If an oblique or transverse section through the rectus muscle heals satisfactorily, it rarely gives trouble afterward. Similar incisions through the oblique abdominal muscles are more often followed by hernia. Such may be the result even though the muscular fibres are separated longitudinally and subsequently sutured. Certainly a muscular fibre if pinched several times during an operation, or firmly pressed, will undergo at least partial atrophy. Some surgeons hope to secure a firm scar by making incisions through the different layers of the abdominal wall not directly under one another, but in different directions, so that they cross one another. This is especially true of a lateral incision, in making which many surgeons separate the fibres of the oblique muscles and those of the transverse muscle.

An incision is called median or paramedian, and, according to its position with reference to the umbilicus, epigastric, mesogastric, or hypogastric. The epigastric incision is suitable for operations upon the stomach, pancreas, left lobe of the liver, and possibly the transverse colon. The hypogastric incision is preferred for operation upon the bladder and pelvic organs, and in cases of tuberculous peritonitis. A mesogastric incision is suited to all other conditions which require an incision in the median line. Sometimes the incision has to extend over more than a third of the distance from the sternum to the pubes.

A right pararectal incision made at the lateral border of the rectus is adapted to operation upon the right lobe of the liver and biliary passages. A pararectal incision made nearer the symphysis may be used for appendicitis. A left intrarectal incision is often made for gastrostomy. Incisions made further to the side will serve to expose the ascending and descending colon and the kidney.

A transverse incision may be made at any level. It is seldom used at the present time, perhaps unwisely so. Vischer recommends a transverse incision one inch above the iliac crest for appendicitis, and

Péan uses a transverse incision from the outer margin of the rectus to the sacrolumbalis for operations upon the kidney.

The oblique incision parallel to the left costal margin was formerly universally employed for gastrostomy and is still used for this purpose. Many operators make a similar incision on the right side for operations on the liver and biliary passages, or to expose the colic flexure.

Mikulicz exposes the biliary passages through an oblique incision beginning at the costal margin in the mammary line and extending to the median line one or two inches above the umbilicus. This incision is parallel to the nerves in this region. If more room is needed, it is gained by extending the incision downward in the median line. Some surgeons make an oblique incision for appendicitis and also for the establishment of an artificial anus in the descending and in the sigmoid colon. Curved incisions are not used much at the present time, although many surgeons employ angular incisions for special purposes. These are described more in detail in connection with diseases of the different organs.

In repeating a laparotomy it is usually well to make a new incision close beside the old rather than exactly in the old scar, so as to open the peritoneal cavity at a point where the visceral and parietal layers of peritoneum are not adherent. Mikulicz excises the old scar so as to be sure to obtain a firm union of the wound. Such a step is to be performed with caution lest adherent organs be wounded. As soon as an opening is made into the free abdominal cavity it is easier for the surgeon to recognize the relations of the parts.

An exploratory laparotomy is justifiable whenever it seems probable that the patient has an affection which may be best treated by operation, although a positive diagnosis cannot be made. It is also justifiable in cases in which the diagnosis is sufficiently clear, but in which it is impossible to say before operation whether or not the patient's condition can be improved by operation. An exploratory laparotomy can often be performed under the influence of a local anæsthetic. The shorter the incision the less the shock to the patient. In many cases Mikulicz makes an incision just large enough to admit one or two fingers, and with these he palpates the abdominal organs in the same manner that examination is made with one or two fingers in the vagina or rectum. But even so small an opening of the peritoneal cavity is not wholly without risk, and this operation ought never to be performed until other means of diagnosis have been exhausted. For the sake of diagnosis alone it should never be performed, since it may reveal conditions which are inoperable—for example, a gangrenous tumor, which makes it impossible ever to close the abdomen again. Furthermore, one can never be absolutely sure that troublesome adhesions will not follow an exploratory laparotomy, and even so small an incision may give rise to a ventral hernia. Then there is also a risk of pneumonia, especially in aged people. In making an exploratory incision one naturally selects the place from which the diseased organ is most readily accessible, or, if one is in doubt what organ is diseased, the incision should be made near the umbilicus.

Technic of Incision.—In the Breslau surgical clinic a laparotomy is performed as follows: The fingers of the operator spread out upon the abdomen lightly draw the skin to be incised in the direction of the incision while countertraction is made by the assistant. This tension is unnecessary in case the skin is already stretched by a large tumor or by meteorism. It is well to make a small incision at first, especially if the extent of the operation is not entirely clear. While a large incision made in the beginning gives the operator a wide view of the field, a relatively small incision possesses several advantages of its own. It can be more quickly sutured, it favors retention of the intestine within the abdomen, it gives rise to less shock, other things being equal, and it is less likely to be followed by hernia. The risk of infection, which formerly was an important point, has to-day become less so. In any case it is easy to extend a small incision should this become necessary. If the umbilicus lies in the line of incision, most surgeons pass it by on the left side. Mikulicz removes it except in the case of young girls. He does this because it is difficult to disinfect the umbilicus thoroughly and its suture takes time. Extirpation of the umbilicus usually opens the peritoneal cavity.

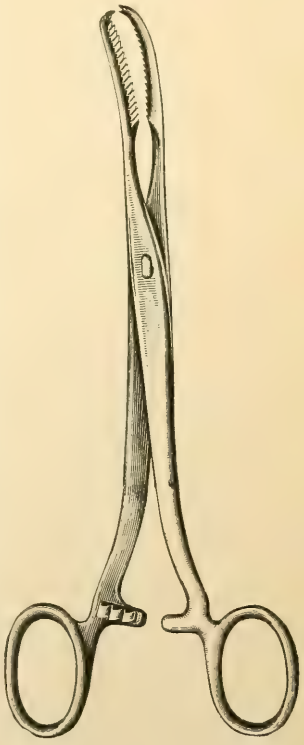
The edges of the incised skin are retracted and the succeeding layers of the abdominal wall are divided with the scalpel exactly in the median line until the peritoneum is reached. If a tumor or a great collection of fluid has stretched the abdominal wall, the edges of the wound immediately retract. If the incision is made exactly in the median line, the sheath of the rectus muscle is not opened. It is easier to avoid opening the sheath in the upper portion of the abdomen than in the lower, since the linea alba is normally 1 or 2 cm. (0.4 or 0.8 inch) broad in the epigastrium. It is still broader at the umbilicus, but rapidly narrows below until it is only 2 mm. (0.1 inch) broad and proportionately thicker. The pyramidal muscles may or not lie in the line of incision. Sometimes they are wanting, and sometimes they cross the median line. If the incision is not a median one, muscular fibres which are encountered are pushed aside if their direction is parallel to the line of incision or nearly so. In other cases they are divided by a clean cut. When this has been done, the transversalis fascia is exposed, which covers the whole front and sides of the abdomen. The thin peritoneum lies immediately beneath it and is attached to it closely in the region of the umbilicus, but more loosely elsewhere. Where the attachment is close, one gains the impression that the peritoneum is a strong membrane, since what appears to be peritoneum is really peritoneum and fascia together. Between the two membranes there is a variable amount of fat which in stout persons may be so considerable that the membranes are separated by an appreciable distance.

As soon as the peritoneum is exposed, any bloodvessels which have been divided should either be ligated or clamped if this has not previously been done. Those vessels which are clamped are twisted or ligated at the close of operation. The peritoneum at about the

middle of the incision is seized with two anatomical forceps, raised and opened with scissors or scalpel. The blade of a blunt-pointed scissors is then introduced and the peritoneal opening is extended upward and downward while the abdominal organs are protected by one or two fingers introduced underneath the peritoneum.

In certain pathological conditions it is extremely difficult to recognize the peritoneum either because it is inflamed and thickened and its vessels are dilated so that it resembles the intestinal wall, or because there are extensive adhesions, so that the wall of the intestine is mistaken for peritoneum, and cut through before its true nature is recognized. The transversalis fascia has often been mistaken for the peritoneum, and the two have been dissected apart under the suspicion that the parietal peritoneum was the covering of some abdominal organ. This mistake delays the operation and leaves a bloody cavity in the abdominal wall. In cases of doubt blunt dissection is advisable, and if a clear view of the relations cannot be obtained the surgeon should try again in another portion of the wound in which the adhesions may possibly be wanting. One is most likely to encounter such difficulties in secondary operations.

FIG. 57.



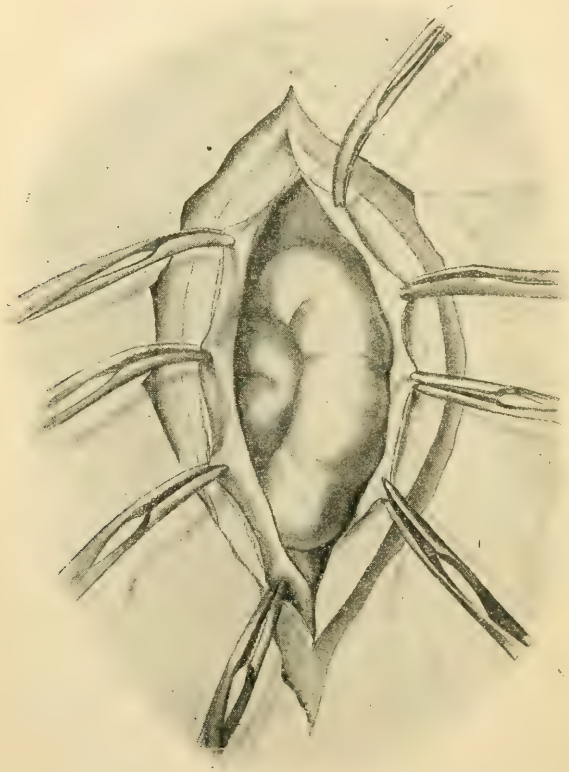
Peritoneal clamp (½ natural size).

When the peritoneum has been divided, its cut edges on either side are seized with peritoneal clamps, whose edges are somewhat bent and terminate in sharp hooks like a rat-toothed forceps. The handles of these instruments are so curved that they lie flat upon the compresses which cover the abdominal wall, while by their weight they keep the edges of the peritoneum in place. This step in the operation serves several purposes. It keeps the peritoneum in its normal relation to the abdominal wall (if it is not so held, it may easily be pulled off by subsequent manipulation), and it protects the peritoneal cavity from bloody secretion which may ooze from the wound in the abdominal wall. Furthermore, it protects to a certain extent the abdominal wound itself in case the operation is a protracted one, or in case an infectious cavity is opened within the abdomen ; and it facilitates suture of the peritoneum when the operation is finished. Some surgeons accomplish the same object by temporarily suturing the peritoneum to the skin.

If the incision is made near the symphysis, care should be taken not to open the bladder accidentally. If necessary, a catheter may be

passed into the bladder in order to show its exact position. Fritsch warns against extending the incision to the symphysis except in case of absolute necessity. He says the division of the loose prevesical tissue and the increased weight with which the abdominal organs press upon a scar so low down predispose to ventral hernia. Unless there is special indication for it, an abdominal incision should not extend higher than the ensiform cartilage for fear of opening the pleural cavity.

FIG. 58.



An abdominal wound in which the cut edges of the peritoneum are drawn outward and held by eight peritoneal clamps (one-half natural size).

Technic of Laparotomy after the Peritoneum is Opened.—The coils of intestine which tend to press out of an abdominal incision are held back by aseptic compresses. The immediate neighborhood of the wound is first examined in order to determine the condition of the peritoneum, the presence of ascites, etc. Further action of the surgeon must be determined by circumstances. In general, if the disease is not apparent, one or more fingers are introduced in order to locate it, and these are followed when necessary by the whole hand. It is sometimes necessary to examine the whole peritoneal cavity.

The peritoneum should be protected not only from bacterial infec-

tion, but also from chemical and mechanical injury, hence retractors or other instruments that are introduced should be free from sharp edges and corners. Every operator has his favorite retractors, so that it is unnecessary to describe these instruments in detail; but no instrument can take the place of the operator's hand, and when this is protected with a sterile glove he introduces it freely. If he finds it necessary to pass the hand and arm into the abdomen, the glove should be taken off, the hand thoroughly washed with a lysol or bichloride solution and dried with a sterile towel. The cloth glove tends to catch upon the peritoneum and delicacy of touch is somewhat impaired by it. For these and other reasons many American surgeons wear rubber gloves during abdominal operations.

One should avoid loosening the peritoneum from the underlying tissue; and if it is torn accidentally, it should be sutured; or if this is impossible, the gap should be closed with a flap of omentum which may or may not be left attached to the rest of the omentum. If the peritoneum is separated from the underlying tissue for a considerable distance and one is not sure of asepsis, the dead spaces thus caused should be tamponed and drained.

It is well to sponge with gentleness. Most surgeons prefer dry sponges. Any secretion which is found should be thoroughly removed, even though it is not infectious. It is claimed that moist sponges are less irritating to the peritoneum than dry sponges and do not predispose to adhesions. This cannot be considered proved as yet. Sea sponges are rarely used at the present time.

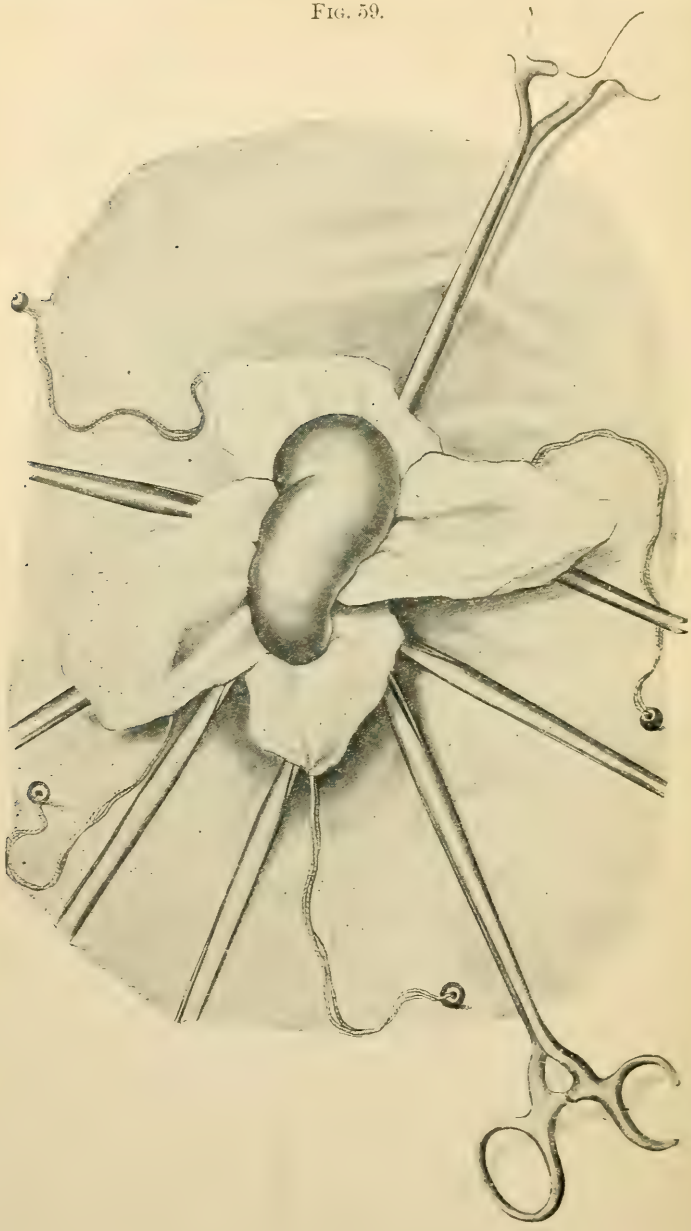
Any fluids which are used in the peritoneal cavity for irrigation or to moisten sponges, etc., must not be of an irritating character. Strong antiseptics should not be used at all, or at most for disinfecting the hands, for instruments, and for suture materials. A 1 per cent. saline solution is the best fluid for general use. On account of the rapid absorption from the peritoneum and its numerous pockets in which fluid may lodge, antiseptics may bring about serious symptoms of poisoning. Even if these symptoms are outlived, they may add to the injurious effect of the operation upon the heart and kidneys. Furthermore, antiseptics injure the peritoneal surface and produce annoying adhesions.

Coils of intestine which are brought outside of the abdomen should not be allowed to touch the skin, but should be quickly wrapped in hot moist sterile cloths so that the air may not injure the delicate organs.

Every ruptured bloodvessel within the peritoneal cavity should be carefully ligated. Even a small vessel which during operation bleeds only slightly may bleed more freely when the general blood-pressure rises after operation. Neglect to tie such a bleeding vessel may cost the patient's life. This risk is especially great in jaundiced patients. Mikulicz and many other surgeons make use of mass ligatures so as to avoid post-operative hemorrhage and also to shorten the time of operation. Thus if omentum or mesentery or broad adhe-

sions have to be divided, the tissue is separated into suitable masses and divided between ligatures. If the tissue which is thus treated is

FIG. 59.



Temporary tamponade with abdominal pads (one-half natural size).

thick, a groove for the ligature is first made by compressing it between the jaws of strong forceps. Mikulicz has seen no injurious effects follow

this treatment, but many surgeons reject it and prefer to divide the tissue first and subsequently to ligate all bloodvessels. Adhesions must be separated when they interfere with the operation, and when they produce subjective or objective symptoms, or may produce such at a later period. Slight adhesions and small cords which contain only minute bloodvessels may be torn through with the fingers or cut with scissors without previous ligation. Close adhesions to organs which are full of blood, such as the liver and spleen, are best divided by the thermocautery in order to avoid troublesome hemorrhage. The greatest care is necessary in separating adherent coils of intestine. If they are torn apart, it often happens that the intestinal wall gives way rather than the cicatricial tissue.

The material employed for sutures and ligatures within the abdomen may be silk or catgut, silkworm-gut, kangaroo-tendon, etc. The peritoneum bears readily almost any suture material whose calibre is not too great. Mikulicz uses formalin catgut for most purposes, but employs fine silk for a Lembert suture.

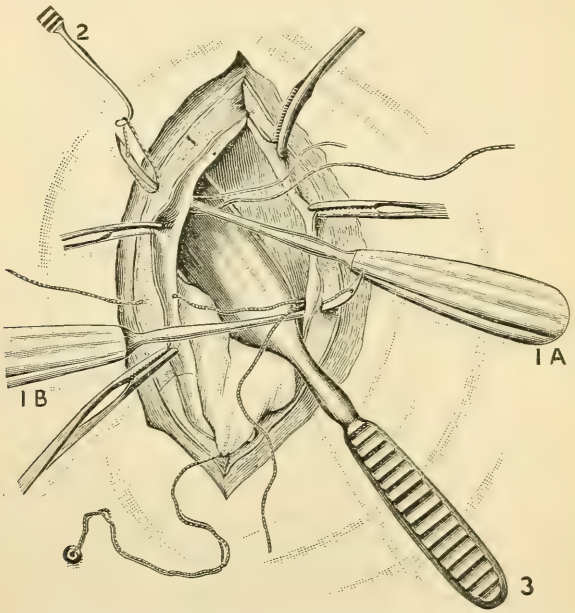
As far as possible a laparotomy should be carried on extraperitoneally. That is to say, if the organ is movable it is brought out of the abdominal wound and surrounded by a row of compresses which are firmly packed into the wound. These compresses may be dry or moist. They either remain in place until the close of the operation, or they may be replaced as they become soiled. This method of operation is easily carried out in the case of the stomach or intestine, and to a certain extent in the case of the bladder and female genital organs. When the affected organ has been brought outside of the abdomen, the wound may be partially closed temporarily by a running suture.

If this method of operating is not possible, an attempt is made to operate in a similar manner within the peritoneal cavity, by shutting off the field of operation from the rest of the peritoneal cavity, using for this purpose broad retractors which lift the edges of the abdominal wound outward and forward, while a row of compresses placed around the affected organ shuts it off from the rest of the peritoneal cavity. In many cases—for example, in most operations upon the stomach—Mikulicz operates half inside and half outside the abdomen. He brings the organ as far forward as possible and then shuts off the field of operation from the rest of the peritoneal cavity in the manner described. In aseptic operations this method of operating has the advantage of lessening the risk of infection of the general peritoneal cavity, and in operations in which the affected organ contains pus the advantage of the temporary tamponade is even more marked. This is the case in operations which open the stomach or intestine, or have to do with abscesses, echinococcus cyst, etc.

Foreign bodies which are left for even a little time in the peritoneal cavity may be removed by peristaltic action, etc., to a considerable distance so that it is extremely difficult to find them again. On this account instruments and sponges which are left loose in a peritoneal cavity are likely to be forgotten. Mikulicz makes it an invariable

rule as soon as the peritoneal cavity is opened never to use a sponge for any other purpose except sponging. If it is necessary to leave any such article in the peritoneal cavity or in the wound, he makes use of abdominal pads to the corners of which are fastened large glass pearls. (Figs. 59 and 60.) Other surgeons make use of other devices to accomplish the same result. Still others count the instruments and sponges after each operation. This, however, takes time and fixes the attention in an unfortunate way upon the instruments and

FIG. 60.



Introduction of buried abdominal suture. The peritoneum is represented as being sutured, together with the deeper layers of the abdominal wall. On both sides the needles are passed from within outward. 1 *A*, 1 *B*, needles with handles showing the first and second steps of suture; 2, tenaculum catching the thread; 3, spatula used to keep the abdominal contents away from the peritoneum.

sponges, and, as experience has shown, does not always accomplish its object. One can avoid leaving instruments in the peritoneal cavity by using only large instruments. This is especially true of artery forceps. The second rule worth observing when operating deep in the peritoneal cavity is to control hemorrhage thoroughly and remove the clamps before proceeding further; or, if this is impossible, the clamps used should be so long that the handles project from the wound.

If a foreign body is left in the peritoneal cavity, it can affect the patient in a number of ways, so that if unusual symptoms arise during convalescence one should think at once of a possible foreign body in the abdomen. This is especially true of porous articles, such as sea sponges or gauze. The local suppuration which takes place in their meshes may spread to the rest of the abdomen, or the foreign

body may become walled off by adhesions. If an abscess is formed, it may perforate in various directions, but usually not through the skin on account of the deep position occupied by the foreign body. Such an abscess often perforates into the vagina and not seldom into the intestine. In this manner the foreign body may escape from the peritoneal cavity, or it may remain for months, giving rise to a profuse gangrenous discharge and exhausting the patient. If it becomes wedged in the intestine, it may produce symptoms of fecal obstruction. If a foreign body, such as an instrument or a small gauze compress, is perfectly sterile, it may become surrounded by adhesions, and remain indefinitely without giving rise to symptoms; or the cicatricial contraction caused in its neighborhood may so press it against the intestine that the bowel is perforated; or perforation of the wall of a vessel and fatal hemorrhage may be the result. Compression of nerves may cause intense pain.

Before closing the abdominal wound it was formerly customary to wash out and sponge the peritoneal cavity. This step in the operation, which has received the name "toilet of the peritoneum," has been generally abandoned except in cases of diffuse purulent peritonitis and in cases in which the peritoneum has been soiled by infectious material. The details of this irrigation with warm 1 per cent. salt solution are given on page 177 of this volume.

If eventrated coils of intestine are much dilated, or the abdominal muscles of the patient are well developed and only partially relaxed, it may be difficult to replace the parts in their normal condition. Elevation of the pelvis is frequently an aid in such circumstances. Or it may be necessary to puncture the intestine in several places, or to make an incision in it to permit the escape of gas and fluid. Such openings should be carefully sutured, and on account of the risk of post-operative peritonitis thereby caused this measure should only be resorted to when all others fail.

Closure of the Abdomen.—The abdomen may either be closed at once by suture of the abdominal wall or the wound may be left to heal by granulation, in which case it is either tamponed or drained. Primary closure gives a prompt union and a firm cicatrix, in which case hernia rarely develops. This method is therefore to be followed whenever circumstances permit.

Primary Suture.—Every operator has his own method of suturing an abdominal wound, and equally good results can be obtained by very different methods. According to the experience and observation of Mikulicz, suture in layers with some material which will withstand disintegration for a considerable time is the best method of closing the wound in the abdominal wall. Those who have inquired into the development of hernia in abdominal scars have found that the closure of an abdominal wound by a single row of sutures is followed by hernia more than twice as frequently as is suture in layers (20 and 30 per cent. as compared with 8 and 9 per cent.). The figures given are for cases of aseptic union. The

percentage of hernia when the wound suppurates is considerably higher; but even then hernia is more common after a single row of sutures than after sutures of the different layers. If one employs a buried suture, it is of the greatest importance that asepsis be perfect. Some surgeons use as many as six rows of sutures in closing the abdominal wall, and the material used and the way in which the stitches are inserted give opportunity for great variation. Besides the materials mentioned on page 213 for use in the abdominal cavity, silver wire and aluminum bronze wire have often been employed. The uncertainty of catgut and even chromicized catgut, as a lasting suture-material, inclines most surgeons to employ some non-absorbable substance. Silk is perhaps the very worst material that can be used, because by soaking up fluid it predisposes to suppuration and is then almost certain to be thrown out. Silkworm-gut may irritate by pressure of its sharp, stiff ends, although this risk is much lessened if the ends of the gut be touched with a Paquelin cautery. Still it rarely happens that silkworm-gut causes suppuration even when used after operations upon the stomach or intestine, and under such conditions the suture is probably not absolutely sterile. Silver wire and aluminum bronze wire possess a feeble antiseptic power. Such wire occasionally gives the patient great pain and has to be removed. It rarely causes suppuration. Some surgeons employ a fine wire gauze, but this seems out of place except in operations upon hernia when it is impossible to bring the edges of fascia firmly together by suture.

Mikulicz's method of closing an abdominal wound is as follows: All sponges and pads are removed and one or more clean pads are introduced in order to protect the peritoneal cavity. As this is accomplished by suture the pads are gradually withdrawn. These pads protect the peritoneal organs from puncture with the needle. If the peritoneum is not tense, it is sutured through a continuous catgut suture. Peritoneum and transversalis fascia should be included in the same suture since the serosa alone is too delicate. For this purpose a curved intestinal needle (Fig. 61) is used and is passed with the fingers alone. The edges of the peritoneal cavity should be exactly approximated in order to avoid adhesions with the omentum and intestine. If the patient is a robust man or for some other reason the peritoneum is very tense, a continuous suture is likely to pull out. Under such circumstances the peritoneum should be sutured in connection with the next layer of the abdominal wall, as is shown in Fig. 60.

Fig. 61.

Curved intestinal needle (three-fourths natural size).

This suture passes through the transversalis fascia and all the layers of the abdominal wall as far as the subcutaneous fatty tissue. The thread is tied in the form of interrupted stitches. The individual stitches are separated from one another by a distance of 1 cm. (0.4 inch) and are introduced from 1 to 1½ cm. (0.4 to 0.6 inch) from the free edge of the wound. In case of a median laparotomy they usually perforate the recti muscles, especially below the umbilicus. Before

each suture is tied the surgeon should be sure that neither intestine nor omentum is caught in the thread. The material employed for this row of stitches is either silkworm-gut or bronze wire.

Muscles which are cut transversely or obliquely are together with their fasciæ firmly stitched by silkworm-gut. Muscles which are separated longitudinally are lightly sewed with a continuous suture, to avoid, if possible, atrophy of muscular fibre. A separate suture is passed through the sheath of the muscle. If the subcutaneous fat is very thick, it is brought together by a continuous catgut suture.

The skin is sutured by means of a large, sharp-curved needle used without a needle-holder. The suture is a continuous one. Many surgeons suture separately the peritoneum, the muscles, the aponeurosis, the subcutaneous tissue, and the skin in order to insure exact approximation. Drainage of the abdominal wall has been abandoned.

The line of incision is smeared with zinc paste and then covered with several sterile compresses which are held in place by three or four strips of rubber plaster. Other surgeons fasten a small dressing over the wound by collodion. Still others encircle the body with an extensive bandage, but this in most cases is unnecessary, as a properly sutured wound secretes only a few drops of bloody serum. An antiseptic dressing is unnecessary and a dressing which is impervious to air is harmful.

Mikulicz, as well as most surgeons, employs a circular bandage around the trunk after a laparotomy in order to keep the abdominal wall as immovable as possible and to protect it from strain caused by vomiting, coughing, deep respiration, etc. Such motions of the abdominal wall cause the patient intense pain ; hence he avoids them as far as he is able. Mikulicz believes that pneumonia can in a measure be prevented by deep breathing, and he therefore requires his patients to take ten or twenty deep breaths several times a day for two or three days after a laparotomy. The small dressing of the wound above described is covered with a larger one of cotton which is held in place by a muslin bandage 20 to 40 cm. (8 to 16 inches) broad, whose length is sometimes less than the circumference of the body. The ends of the bandage are provided with hooks so that it can be held firmly in place by lacing. One can then lace it loosely or tightly and can quickly lay the ends back for a change in dressing without disturbing the patient. The pad of cotton should be greater in the case of emaciated patients or if a large abdominal tumor has been removed.

If no unusual symptoms develop, the dressing is not disturbed for eight or ten days. The cutaneous stitches are then taken out and a light dressing applied for another week. If there is no buried suture, some of the stitches must be left in place longer than ten days. In any case the tender scar must be supported for one or two weeks longer by means of adhesive plaster and a circular bandage. In most cases the abdominal wound heals without drainage. Occasionally there is some redness, or even a small abscess in connection with one or more stitches. This usually amounts to nothing. If an intramural abscess

forms, the suture-line must be opened for a short distance in order to drain the abscess cavity.

A permanent abdominal bandage is usually unnecessary if the abdominal wound is sutured in layers. If the abdominal wall is lax, such a bandage may add to the patient's comfort. A ventral hernia rarely develops later than six months after a laparotomy.

Incomplete Closure of the Abdominal Wound.—The abdominal wound should be left wholly or partly open if hemorrhage is not thoroughly controlled or after doubtful suture of hollow organs which contain bacteria; in case of extensive injury or defect of the peritoneum; and in case great quantities of virulent bacteria have infected the peritoneum either before or during the operation. Under such circumstances the part of the abdominal cavity in question should be drained or tamponed. No exact rules can be given to govern the necessity of this treatment since it depends upon the skill of the operator, the certainty of asepsis, and, furthermore, every operator must be governed by his past experience in judging of the resisting power of the peritoneum in any given case. As a rule those who have had less practice and experience will do well to employ tamponade in all cases in which they are in doubt.

In reference to the four points above mentioned, it may be stated that hemorrhage, especially from such vascular organs as the liver, spleen, and pancreas, cannot always be controlled by ligature either direct or through the tissues, nor by cauterization.

A suture through the stomach and intestines can usually be relied upon if the tissues are in a normal condition. If, however, they are inflamed or emaciated, the suture is not always to be trusted. This is always the case with a suture of the large intestine. Even the most approved method of suture may fail under such circumstances. Suture of the gall-bladder and ligation of the cystic duct with extirpation of the gall-bladder and suture of the common duct are not always to be trusted. Suture of the stump of the appendix, provided the inflammation is not too great, rarely gives subsequent trouble. If portions of the peritoneum are injured or are wanting, the wound lacks the protection which the normal peritoneum affords. Such wounds were formerly dreaded. They give less trouble since surgeons operate aseptically. Up to six years ago Mikulicz was accustomed to drain such a wound most thoroughly. Since then his aseptic technic is so certain that he does not tamponade the peritoneal cavity, feeling sure that no harm will follow a moderate oozing of blood or an extensive injury of the peritoneum.

Quantities of virulent bacteria may reach the peritoneum during an operation, as, for example, in the opening of an abscess or a hollow organ, and they may have reached the peritoneum before operation in case of perforating wounds. Under such circumstances, as well as in the presence of a purulent peritonitis, the peritoneal cavity must never be closed. This rule holds good for acute serous effusion which is considered to be possibly infectious. Schauta and others have pointed out that encapsulated pus which has remained for some time in the abdomen

may be found sterile, presumably because the pus-creating organisms have perished. Such pus may be examined at the time of operation, and if found free from bacteria, the peritoneal cavity may be closed. Hahn examines suspicious peritoneal secretion and drains the peritoneal cavity if it is found to contain streptococci; otherwise he closes the peritoneal cavity without drainage. Mikulicz considers this practice somewhat risky since one rests too absolutely upon the microscopical examination.

Drainage.—There are two methods of draining the peritoneal cavity, by a tube or by capillary attraction. The latter method is far more efficient for the following reasons:

1. The secretion will only flow down hill through a tube, unless the pressure within the cavity is sufficient to force it up out of the wound. Such increase of pressure can be obtained in many parts of the body by a bandage, but in the abdominal cavity this is not possible. Even when the tube is situated in the lowest portion of the abdominal cavity, for instance, in Douglas's pouch or in the lumbar region, it cannot properly drain the peritoneal cavity for the reasons mentioned below.

2. The drainage-tube which is introduced into the peritoneal cavity lies not in a simple wound, but in a space which is full of many movable organs. These organs constantly move in the direction of the least resistance, and consequently block the openings of the drain no matter how numerous they may be. This statement has been verified by experiments and by clinical observation. It is only when there is a considerable quantity of fluid exudate under a relatively high pressure that a part of it escapes through a drainage-tube.

3. Adhesions form as quickly about a drainage-tube as about any foreign body, so that it is soon shut off from the peritoneal cavity. Therefore if the objections mentioned in the two preceding paragraphs did not exist, this third condition would soon limit the action of a drainage-tube to the narrow space which it occupies.

4. A drainage-tube may produce an ulcer in the tissues which it touches. In this manner perforation of the intestine may be brought about.

For the reasons given a drainage-tube ought never to be employed in the peritoneal cavity except in the case of previously existing abscess cavities which can be easily reached by the tube. The use of a drainage-tube in connection with gauze and the use of the tube for repeated irrigation are spoken of below.

A Mikulicz gauze tampon accomplishes the following objects:

1. It tends to stop hemorrhage. This is a well-known property of a gauze tampon, and if necessary it may be increased by filling the tampon with some substance having styptic properties (penghawar).

2. The absorbing power of a gauze tampon is due to capillary attraction. This can be shown by experiments upon animals or in the laboratory. This power of the tampon varies with the material of which it is made. When the tampon is thoroughly saturated, it will not take up more fluid unless there is siphonage, or an evapora-

tion of fluid from its surface. As long as a current is kept up by these means fluids from the wound, poisons, accumulating pus, bacteria, etc., will be carried outward. When the flow stops, such materials, and especially bacteria, will work inward. While it is not safe to assume that the results of a laboratory experiment will be obtained in a wound, still a gauze tampon is an excellent drain. It is only necessary to afford the fluid which has been soaked up an opportunity to evaporate and to prevent the surface of the drain from becoming sealed over by dried secretion. If the gauze drain is covered by some material which is impervious to moisture, its advantages are at once lost and it does harm rather than good. Theoretically if such a drain is properly placed in a wound, secondary infection is an impossibility. As a matter of fact, such a drain becomes filled with bacteria from without sooner or later, but by the time this occurs the peritoneal cavity has protected itself by firm adhesions. Capillary drainage with gauze fails if the secretion is very thick. Such a secretion merely blocks the meshes of the gauze.

3. The gauze tampon facilitates protection of the rest of the abscess cavity. Like every foreign body, it stimulates the peritoneum to the formation of a plastic exudate which unites one intestinal coil to the next, and that to the parietal peritoneum, etc. This makes it possible for the operator to isolate any portion of the peritoneal cavity, large or small, which is accessible to the gauze tampon. In eight days at the longest the cavity which he has tamponed is lined with granulations, and those which spring from the peritoneum are in no respect different from those which spring from the raw surface either in appearance or in their power to protect the body against the entrance of bacteria. The adhesions which form about the tampon are well marked within a few hours, while in twenty-four hours they are so firm that it is safe to trust to their perfect closure of the peritoneal cavity.

This gauze drainage is employed to isolate suspicious portions of the peritoneal cavity, such as an uncertain suture, or a part where the peritoneum has been injured or is wholly wanting. If there is perforation of a hollow organ which the operator can not or does not wish to suture, it can be walled off with gauze tampons so that the secretion will be conducted outward and will not injure the general peritoneal cavity. This is true of openings in the gall-bladder, stomach, intestine, etc. If it is deemed best to close the opening in a hollow organ at a later date, the gauze tamponade is employed for two or three days, or for even a less time if there is necessity of haste. In the latter case it is well to fix the opposing peritoneal surfaces with a few sutures. If an organ is involved whose movements interfere with the formation of adhesions, circularly placed gauze may be kept in position by a few catgut stitches.

Furthermore, suture is employed to isolate certain sections of the peritoneal cavity or to close over raw spaces with peritoneum. This is especially true after abdominal or vaginal laparotomy for diseases of

the female pelvic organs. By making use of the uterus, broad ligament, etc., one can make a diaphragm across the pelvis; and if the peritoneum to be obtained is not sufficient for the purpose, the gap may be filled by neighboring organs, such as the cæcum or sigmoid colon, or appendices epiploicæ, or the lower portion of the mesentery. In this manner the lower portion of the peritoneal cavity may be completely shut off and drained through the vagina, or through the lower angle of a wound in the median line of the abdomen.

4. If a tampon is impregnated with iodoform, it is antiseptic to a certain degree. It is evident that this action is an extremely limited one. Even a freely soluble concentrated antiseptic introduced into the secretion of a wound will soon be carried out by the flow. Therefore it is necessary to employ some antiseptic which is very slightly soluble, and such an one can never have strong antibacterial power. If large peritoneal surfaces are to come in contact with the tampon, Mikulicz uses only sterile gauze on account of the risk of iodoform-poisoning.

Objections may be urged to the use of the Mikulicz tampon:

1. When a tampon has remained for some time in the peritoneal cavity, it is difficult to remove it because its meshes are filled, first, with a fibrinous exudate and, later, with granulations. On this account some operators introduce the gauze through a rubber or glass tube or wrap it about with gutta-percha tissue, but even then adhesions may form through the lateral openings or at the end of the tube. A better plan is to loosen gauze which is firmly adherent by irrigation with a solution of hydrogen peroxide.

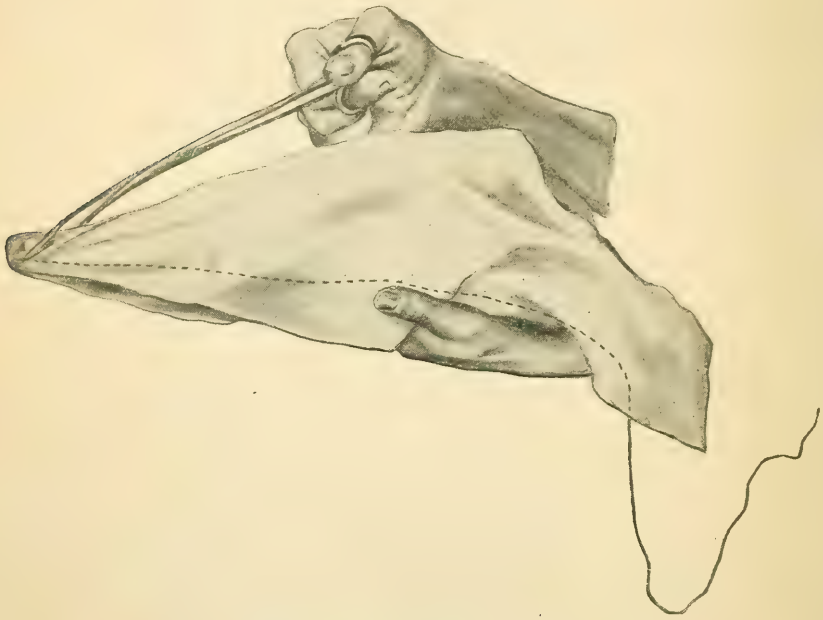
2. A wound which has been tamponed frequently becomes the seat of a ventral hernia. Even a secondary suture will not always prevent this. Fritsch has tried to overcome this tendency of a gauze tampon by introducing a very long, narrow strip of gauze spread out like a fan and which emerges through a small portion of the wound, the rest of the wound being sutured. Such a small opening does not drain well. Investigation by Pichler shows that hernia does not often develop in wounds which are drained as a precaution and which heal aseptically. Most ventral herniæ develop in wounds in which there was at the time of operation an infectious secretion, or which subsequently became the seat of secondary infection of a severe type.

A gauze tampon is capable of draining only a small portion of the peritoneal cavity. As soon as adhesions form, and they do so in most instances in a few hours, the tampon only drains the portion of the peritoneal cavity immediately about it. As it is utterly impossible to introduce gauze into all the ramifications of the peritoneal cavity, a permanent drainage of its many spaces is out of the question. Rehn by repeated irrigation in diffuse peritonitis has prevented the formation of adhesions for three days.

In order to tampon a cavity, take a square piece of sterile or 1 per cent. iodoform gauze the size of a large handkerchief and fasten to its centre a long strong silk thread. Fold the cloth loosely together so

that its centre forms a point with the silk thread left within it. Seize this point with a pair of dressing-forceps (Fig. 62) and pass it into the peritoneal cavity. In most instances one such piece of gauze is sufficient; if not, others may be introduced. When the gauze is in place, it is opened and filled with strips of sterile or iodoform gauze. If the cavity to be tamponed is of irregular shape, the gauze should be introduced into all the pockets. If there is constant oozing, styptic gauze

FIG. 62.



Introduction of a Mikulicz gauze tampon.

may be used; and if a large secretion is anticipated, for example, from some open biliary duct, a rubber tube should be placed within the gauze handkerchief. If it is feared that respiratory or peristaltic movements will displace the gauze handkerchief, it may be stitched to the affected organ with catgut.

Displacement of the tampon and prolapse of abdominal organs may be prevented by catgut sutures between the tampon and muscles or fasciæ. This suture should never include the skin.

The abdominal wound is usually partially closed by suture. The space left must be great enough to avoid compression of the tampon. A dry dressing of absorbent gauze is laid upon the tampon and held in place by a bandage easily pervious to air. This external dressing should be changed every day or two.

Such a tampon may remain in place four or six days if no unfavorable symptoms arise. By that time it will either become loose or it may be loosened intentionally with the help of a 1 per cent. solution

of hydrogen peroxide. It is utterly impossible to remove a whole tampon at once without exerting too great traction upon it, and the plan followed should be to pull out the looser portions and to complete the extraction a day or two later, at which time traction upon the string will complete the removal of the tampon. If the foam caused by the hydrogen peroxide obscures the field of vision, it may be washed away with a sterile saline solution. Such irrigation cleanses the remaining portion of the tampon, but even under the most favorable conditions the tampon will not remain sterile more than a few days. Therefore it is better to irrigate the wound until the water returns perfectly clear. If the cavity of the wound is deep and broad, additional pieces of iodoform gauze should be lightly introduced so that the external wound shall not close too soon. Before the external dressing is applied, 20 or 30 drops of a 10 per cent. solution of carbolic acid in glycerin or pure glycerin are sprinkled between the folds of the tampon.

If symptoms of iodoform-poisoning develop, such as rapidity of pulse, restlessness, headache, nausea, and general weakness, and these symptoms cannot be explained in any other way, an iodoform gauze tampon ought to be removed at once. This requires greater caution than usual in order not to break up the light adhesions between peritoneal surfaces. On account of the danger of iodoform-poisoning only sterile gauze should be employed if the patient suffers from renal trouble or is otherwise in poor condition, or if the tampon is to be a very large one. Loosening or removal of a tampon will be required if it makes too great a pressure upon any organ.

When the tampon has been removed, strips of gauze smeared with a salve containing 1 part of silver nitrate, 10 parts of balsam of Peru, and 100 parts of vaselin are inserted into the wound. If the wound is large, it may be sutured secondarily. If this is done, a vent must be left for drainage with gauze or a rubber tube, or the wound may be filled with carbolic glycerin. Excessive granulations springing from the edges of the abdominal wall may be curetted away before suture. The introduction of secondary sutures at the time of operation which are left to be tied some days later, is not good practice because the presence of the sutures in the wound for several days predisposes the secondary suture to suppuration, and by the judicious use of a local anæsthetic the secondary suture can be introduced with little or no pain.

AFTER-TREATMENT—COMPLICATIONS.

As soon as the operation is completed, the patient is transferred to a warm bed, where he is placed upon his back with head and shoulders slightly raised. If much blood was lost during operation and symptoms of anæmia are present, the foot of the bed should be raised so as to depress the head and shoulders of the patient. An air cushion or water cushion should be placed under the hips of every patient upon whom a laparotomy has been performed, in order to prevent the formation of a bedsore.

The patient must remain in bed at least ten days. Every unnecessary movement of the trunk should be avoided for the first few days. If it is desirable to change the patient's position, this should be accomplished by turning or lifting him, and not by his own exertions. Many surgeons allow a patient to get up in less than ten days. This practice is as a rule undesirable, although it may be necessary in the case of old individuals or those predisposed to respiratory affections. For example, it may be well to lift the patient from his bed to an easy chair two or three days after a gastrostomy or gastro-enterostomy has been performed.

On the day of operation nothing should be given to the patient by mouth unless thirst is very great, as it usually is if much blood has been lost. Under such circumstances cold water may be given by spoonfuls at not too frequent intervals. The rules for diet vary according to the nature of the operation. In general one may begin with a fluid diet, such as milk, soup, and a little wine, on the second day following operation, and to this may be added simple solids one or more days afterward according to circumstances. For example, it is useless to keep the patient upon a strict diet after an exploratory laparotomy; and, on the other hand, if an extensive operation has been performed, he may be injured by too great haste in allowing him a varied diet. This is particularly true after operations upon the stomach and intestine. If fluid cannot be taken by the stomach, thirst may be relieved by rectal injection and normal saline solution administered subcutaneously or into a vein.

Vomiting as a result of etherization usually ceases in twenty-four hours, although in rare cases it may continue for two or more days. At first no drugs should be given to control it, but if it continues small hypodermic injections of morphine are helpful, while bits of ice may be swallowed and an ice-bag placed upon the stomach. If vomiting continues longer than forty-eight hours, some cause other than the narcosis should be searched for.

The passage of gas per anum is usually suspended for a day or two after a laparotomy. If the patient is comfortable, no treatment is necessary. If the abdomen begins to distend, a rubber or glass tube should be passed into the rectum, and may often be left there with advantage for several hours at a time. If the alimentary canal is thoroughly emptied at operation and only a fluid diet is given, there may be no defecation for a week. If the time is longer than a week, an enema should be given. Some surgeons move the bowels in four or five days by means of an enema or glycerin suppositories or laxatives. But if the intestine is thoroughly empty before operation, nothing is to be gained by an early evacuation. It has been said that adhesions can be prevented by this means, but this statement needs proof. A rigid asepsis appears to be a better preventive of adhesions and does not distress the patient. The administration of laxatives to stimulate peristalsis in beginning peritonitis and threatened intestinal paralysis is quite another matter.

Formerly the practice was widespread of administering opium after a laparotomy, and especially after operations upon the alimentary canal. This practice has few followers at the present time. The advantages gained by an absence of peristalsis in the days following operation are more than counterbalanced by the disadvantage of the subsequent passage of hardened feces. It is possible that the administration of opium may favor the formation of adhesions, since adhesions form with difficulty about an organ which is in constant motion, such as the liver. However, opium, by lessening the peristalsis, must also act to lessen the peritoneum's power of resorption, and under certain circumstances it must greatly increase the risk of septic infection. If pain is great, morphine is preferable to opium and should always be administered subcutaneously. Given in this manner in suitable doses it does no harm, and according to many writers it assists the patient in overcoming septic infection. Whether it does good or harm in the presence of an attack of pneumonia is an unsettled question.

Some patients are unable to pass urine. This may be due to the position of the patient, or to the change in intra-abdominal pressure, or to a reflex effect upon the bladder of the operation. Some surgeons advise a patient to practise urination while lying upon the back for a few days previous to operation. If no urine is passed voluntarily for twenty-four hours, the bladder should be emptied by a catheter. This should be done earlier if the pressure of urine within the bladder makes a patient uncomfortable.

The serious complications which may follow laparotomy are : 1, collapse ; 2, secondary hemorrhage ; 3, gastric hemorrhage ; 4, ileus ; 5, peritonitis ; 6, pneumonia ; 7, thrombosis and embolism.

1. Collapse occurs after laparotomy much more frequently than it does after other operations. It may occur in the form of shock immediately at the close of operation, so that the patient recovers from the antiseptic very slowly, or perhaps not at all, and death may result without his regaining consciousness. In other cases the patient recovers from the antiseptic, and symptoms of collapse do not manifest themselves for some little time thereafter. If in this period between recovery and collapse the condition of the patient is thoroughly good, the diagnosis of collapse should be made with great caution, since it is apparent that the unfavorable state is due to either a secondary hemorrhage or a rapidly spreading peritonitis. This is a most important distinction, since the treatment in the two conditions is widely different.

A patient in collapse should be kept absolutely quiet with his head low. Cardiac activity may be stimulated by external heat, subcutaneous injections of camphor, etc. If much blood has been lost, one or one and a half litres of a 1 per cent. saline solution should be injected subcutaneously. The rule should be to inject the fluid slowly until the pulse becomes passably good. If the injection is continued beyond this point, the increased blood-pressure may discharge a thrombus or improperly placed ligature and thus increase the hemorrhage. Collapse may be

further due to the toxic influences of the anæsthetic or of antiseptics which may have come into contact with the peritoneum during the operation.

2. Secondary hemorrhage produces the symptoms of acute anæmia. This is a more serious symptom if the patient has recovered from the anæsthetic and for a time seems to be in good condition. If the symptoms are severe, the abdominal cavity should be opened and the bleeding vessel searched for. If a diagnosis of secondary hemorrhage is made, one ought never to inject saline solution subcutaneously or into a vein.

3. Gastric hemorrhage or hemorrhage from the intestine may follow opening and suture of either of these organs. Under such circumstances blood may be vomited or passed per anum. Gastric hemorrhage may follow laparotomy although the alimentary canal has not been operated upon. This is not infrequently the case if the omentum or mesentery is extensively ligated. v. Eiselsberg believes that small emboli, possibly venous emboli due to the back-flow of the blood-stream, are the cause of such hemorrhages. Gastric and intestinal hemorrhage may also occur after laparotomy which does not involve any portion of the alimentary canal, although the possible cause in such cases may be a too great stretching of the mesentery to overcome adhesions, etc.

Fig. 63.

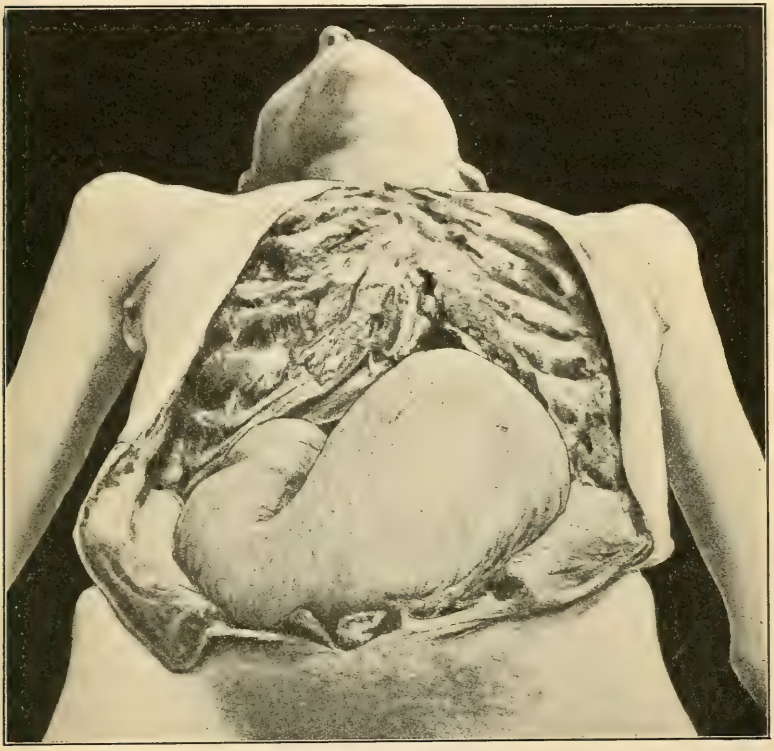
Shape of stomach in acute dilatation.

4. Ileus makes itself manifest two or three days after a laparotomy by a continuation of the vomiting, a change in the character of the vomited material so that it becomes bilious or even fecal, by the failure of gas to pass the anus, by distention of the abdomen, and by the inability of rectal injections to stimulate peristalsis. It is noticeable in these cases that the general condition of the patient is good, as shown by the temperature and pulse, and that septic symptoms are absent. It is necessary to make a differential diagnosis between ileus and peritonitis, and this is oftentimes extremely difficult. In fact, the two conditions are not infrequently associated or one passes into the other.

Ileus may result from peritonitis, as already stated. It may also exist without peritonitis as a simple intestinal paralysis, or it may be due to mechanical causes such as adhesions, or a kink or a twist of a loop of the intestine. Intestinal paralysis may be a direct result of contusion or other injury received during the operation, or it may be due to a circumscribed peritonitis. Intestinal atony of a mild degree often follows a simple laparotomy and disappears in a few days. Kinking or twisting of the intestine may be produced by the operator par-

ticularly if the intestines have been brought outside of the peritoneum. Kinking may also be produced by rapidly forming adhesions which serve to fix the intestinal loop in an unfortunate position. Obstruction may also be caused by pre-existing bands, gaps in the mesentery, etc., or by one or more bridges caused by anastomoses, etc. An example of this is the compression of the transverse colon by the jejunum in anterior antecolic gastro-enterostomy.

Fig. 64.



Acute dilatation of the stomach complicating lobar pneumonia and pleurisy.

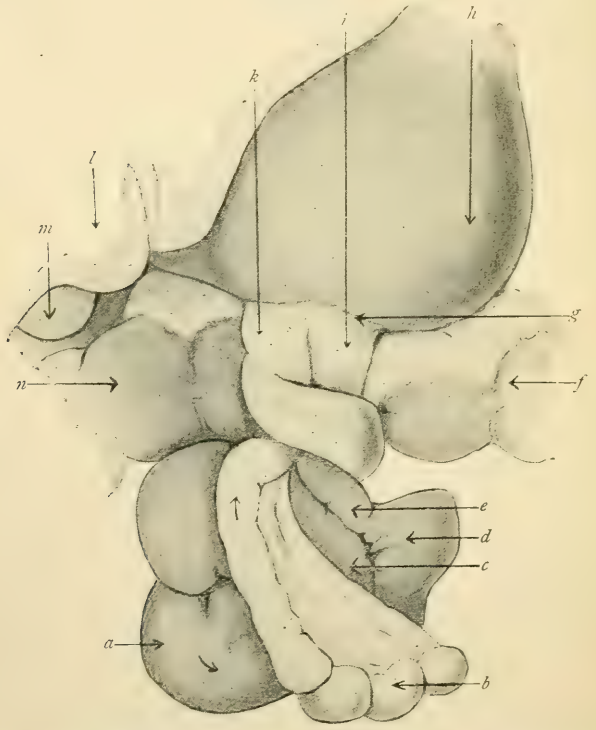
Acute dilatation of the stomach is a form of paralysis which may follow operation upon the abdomen or acute infectious disease. (Figs. 63 and 64.)

If ileus is suspected, all nourishment by mouth should be stopped, the stomach washed out as often as may seem necessary, and the rectum and lower colon irrigated with two or three litres of saline solution. A nutritive enema may follow irrigation. If it is probable that the ileus is due to intestinal paralysis or to a slight kinking from fresh adhesions, it is allowable to stimulate peristalsis by laxatives given by mouth and by glycerin suppositories, etc. If ileus is due to a more serious mechanical obstruction, the abdomen should again be opened

before the patient's strength is exhausted and before peritonitis develops. (Figs. 65 and 66.) This subject is more fully discussed on page 345. Vomiting due to the establishment of a vicious circle after a gastro-enterostomy is discussed on page 437.

5. Peritonitis. A laparotomy is often followed by a slight increase in temperature which has no special significance. If the temperature reaches 38° or 38.5° C. (101° to 101.5° F.) without obvious cause, such as pneumonia, it is always a grave sign. The condition of the

Fig. 65.

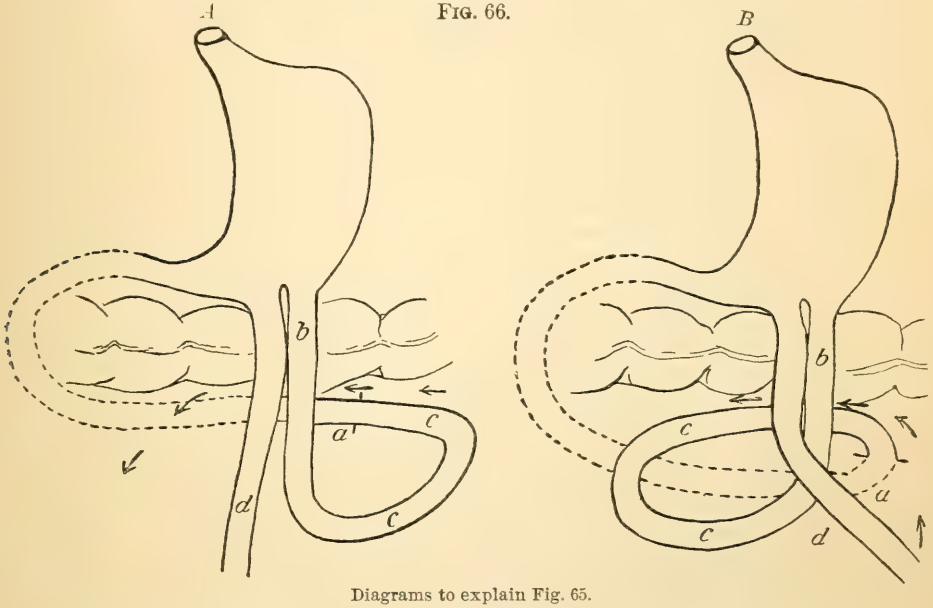


Volvulus of the jejunum after gastro-enterostomy: *e*, enterostomy: *f*, *n*, colon: *g*, gastro-enterostomy; *h*, stomach; *l*, liver; *m*, gall-bladder; *a*, *b*, *c*, afferent bowel; *d*, *k*, efferent bowel.

pulse is even more important than that of the temperature. If it remains below 100 and is of good quality, one need not feel disturbed; but if it is considerably higher and its rapidity is increasing while its character is becoming smaller and softer, the outlook is serious. If it steadily rises until it exceeds 120, the diagnosis of peritonitis is very probable; but even then the patient may recover without further operation. If it reaches 140 and is thread-like, and cyanosis and coolness of the extremities and face develop, the case is almost hopeless. A cold perspiration breaking out on skin which was previously dry and hot is a symptom which closely precedes death.

Naturally a rapid pulse may be due to other causes than peritonitis, such as an excitable temperament, a previous myocarditis, the effect of morphine, iodine, or other drugs. But under these circumstances the pulse does not steadily increase in rate and the other symptoms mentioned are wanting. Further symptoms of peritonitis are abdominal pain and tenderness on pressure, hiccough, and vomiting. But these symptoms, like the fever, are less significant than the pulse, and in certain cases they are wanting. This is particularly true of patients who are much run down, in whom severe or diffuse peritonitis may run its course without temperature elevation.

FIG. 66.



Diagrams to explain Fig. 65.

A, position after operation; *B*, position after the twist began; *a*, *b*, *c*, and *d*, same as in Fig. 65.

Abdominal tenderness on pressure may be slight, especially if the patient has been given morphine. Meteorism is a symptom which is always present in the later stages of ileus. It has little significance of itself, since it may occur in simple atonic conditions of the intestine; but as it is never wanting in a late stage of peritonitis, its presence or absence may serve to decide a differential diagnosis. As a rule it increases in conformity with the increase in the pulse-rate.

The skin of the peritonitic patient is dry. The symptoms of general sepsis seen in peritonitis are a dry skin, a coated tongue, a decrease in excretion, and a peculiar alteration in the feeling of the patient, which is best described by saying that he feels wretched. As soon as the practised surgeon enters the patient's room he recognizes the presence of this symptom by two vertical creases between the eyebrows (facies abdominalis). Such a patient cannot clearly describe his feelings. His gradually increasing pulse will confirm the

suspicion of the surgeon; and later, restlessness becomes more marked. At a still later period the patient often experiences a feeling of great comfort, the result of general intoxication.

While the different forms of peritonitis are described in detail elsewhere in this volume, those symptoms are properly mentioned here which, developing after operation, have a bearing upon prognosis and treatment. Thus it is important to know when a second laparotomy is indicated. The surgeon must distinguish between two forms of peritonitis which occur under such circumstances.

True diffuse peritonitis may follow operation on account of germs introduced from without by reason of faulty technic, or the germs may have been derived from some hollow abdominal organ and spread throughout the peritoneal cavity before the operation. Under such circumstances it is useless to reopen the peritoneal cavity, as the process is so widespread that it is not possible to attack it successfully. This has been tried many times without success. Moreover, such an infection of the peritoneum may be recovered from if it is not too extensive. To perform a second laparotomy lessens the chances of the patient for spontaneous recovery. Such a patient's strength should be kept up, and restlessness and pain should be controlled with morphine. Good results may follow the application of hot moist compresses from the thighs to the breasts. French surgeons recommend irrigation of the vascular system brought about by repeated large saline injections. They do this in the hope of eliminating toxins. The immediate effect is often striking, since the scarcely perceptible pulse grows stronger, the dull eye brightens, and consciousness returns. Unfortunately the improvement disappears in a few hours and the results of subsequent injections are less and less marked. Sometimes death may be postponed some hours or even a day by such methods, but in Mikulicz's experience no patient has been cured of a true diffuse peritonitis by these means.

A peritonitis which starts from faulty ligation or suture of the stomach or intestine or other organ which contains bacteria is quite different. It begins as a local process and does not spread until later. It is comparable to a subacute perforative peritonitis. Under such circumstances prompt opening of the abdominal cavity, exposure, and tamponade of the infected area may save a patient who would otherwise be lost.

A distressing hiccough may occur in any form of operative peritonitis, and, indeed, may be due to peritoneal irritation without inflammation. This symptom is difficult to control. Some remedies which have been used with benefit are bits of ice swallowed plain or after dipping them in a 1 per cent. solution of cocaine, ice-water by spoonfuls, cold lemonade, well-shaken champagne, and various hot drinks such as tea or lemonade. The most efficient drug is morphine injected subcutaneously.

6. Pneumonia, and especially bronchopneumonia, occur more frequently after laparotomy than after other operations of equal magnitude. There are several causes for this. The patient may inspire mucus,

etc., after vomiting. Respiratory motions and expectoration may be limited by abdominal pain. There may be small emboli in the lungs or the vagus nerves may be irritated or paralyzed. The subject needs further study.

Whatever the cause, a considerable percentage of patients are attacked with pneumonia after laparotomy, especially patients beyond middle age. It must be admitted, however, that a number of the patients whose lungs at autopsy exhibit pneumonic processes have died from other causes than pneumonia, and doubtless material from the stomach which is found under such circumstances in the bronchial tubes has sometimes entered them during the death struggle and has had nothing to do with the death itself. The treatment of pneumonia occurring after laparotomy has no peculiarities. One should not fail to control abdominal pain so that a patient can expectorate with comfort. If the patient is old or suffers from emphysema or chronic bronchitis, it is well to keep his shoulders somewhat elevated and to turn him upon his side from time to time.

7. Thrombosis of the vessels of the abdominal cavity, especially of its pelvic portion, may produce thrombosis of the veins of the lower extremities or pulmonary embolism. In doubtful cases the patient should be kept in bed for a long time. Thrombosis and embolism of the smaller vessels of the mesentery are spoken of under paragraph 4.

MALFORMATIONS, INJURIES, AND DISEASES OF THE STOMACH AND INTESTINE.

By Prof. J. v. MIKULICZ and Dr. W. KAUSCH.

CHAPTER XII.

EXAMINATION OF THE STOMACH AND INTESTINE.

METHODS OF EXAMINATION OF THE STOMACH AND INTESTINE.

There are certain diseases of the stomach and intestine the treatment of which is sometimes medical, sometimes surgical. If a patient who is suffering from one of these affections is not seen by a surgeon until medicinal treatment has proved useless, the most favorable time for surgical treatment will have passed. There are other reasons which make it desirable that a surgeon should be consulted early in the disease. For example, the exact relation of an ulcer or tumor to the surrounding organs may not signify much to the physician, but it may be of the greatest importance to the surgeon in view of possible operation. On the other hand, it is of great importance that the surgeon should be well informed in the differential diagnosis of these diseases, and hence the general points in their pathology and symptomatology are here given as well as the principles of their surgical treatment.

Inspection.—The characteristics of the abdomen which may be determined by inspection are configuration; meteorism; dilatation of veins and other changes in the skin; local swelling due either to tumor or a local meteorism; movements of the tumor due to respiration, peristaltic action of the stomach or of the intestine, etc.

Slight differences in configuration in the right and left side of the abdomen are best recognized if the patient lies in dorsal decubitus and the surgeon stands at some little distance from the patient exactly in the median line.

If there is a possible affection of the large intestine, the two lumbar regions should be compared while the patient stands or sits or lies prone upon his face. Differences in distention in the ascending and descending colon may account for differences in appearance of the right and left lumbar regions; and if percussion confirms the testimony

of the eye, the existence and seat of some obstruction will be rendered probable.

Palpation.—While palpation is perhaps the most valuable method of examination for the surgeon, it is a difficult method of examination and requires much practice. It is usually of little service unless the abdominal muscles of the patient are relaxed. The best position to accomplish this end is dorsal decubitus with the head slightly raised, and in some cases the mouth open and the thighs flexed. While the patient breathes deeply the surgeon makes use of the relaxation of the muscles occurring during inspiration to carry out his examination. This is especially true of the deep inspiration which follows protracted crying in children. Palpation may also be carried out with a patient lying upon his side, or crouching on his knees and elbows, or lying on his back with the pelvis elevated. Under some circumstances it is of advantage to palpate the patient in a sitting or standing posture, or lying in a warm bath. The examining hand may be placed flat upon the abdomen or the fingers may be slightly flexed. In mapping out the border of a tumor the fingers should be flexed still more, so that their tips may press against the abdominal wall. Sometimes both hands are placed side by side, or, if firm pressure is required, one may be placed on the other. The upper hand then exercises most of the pressure while palpation is made with the lower. In most cases a light pressure will reveal more of the intra-abdominal condition than firmer pressure, since the latter easily excites muscular contraction. In some cases it is of advantage to place one hand in the lumbar region and the other on the front of the abdomen. This bimanual examination is spoken of in connection with renal tumors.

Palpation differentiates well-defined tumors from an indefinite resistance such as is due to intra-abdominal inflammation or local contraction of the abdominal muscles over a sensitive portion of the peritoneum. Such a local contraction occurs often in disease of the stomach or intestine and can easily lead to a mistaken diagnosis. If a tumor is present, palpation should show its size, shape, and possible changes in shape (tumors of hollow organs, fecal tumors), relation to the surrounding parts, surface, consistence (fluctuation), creaking (echinococcus), density, pulsation (not to be confounded with transmitted aortic pulsation), etc. It is most important to determine the possible motion communicated to a tumor by respiration, or by palpation (passive motion), or by distending the stomach and intestine. Any region of especial tenderness or contraction or gurgling should also be noted. The usual sites of hernia are to be palpated, and if there exists a wide umbilical or ventral hernia it may be possible to pass the fingers through the ring and so palpate with unusual distinctness many of the abdominal organs.

If a patient is thin and has relaxed abdominal walls, the cæcum and a portion of the ascending colon, a portion of the descending colon, and sigmoid can be readily palpated even though empty. The empty transverse colon is not so readily felt. When the colon is distended, it is

often palpable throughout its whole length with the exception of the right and left flexures and the lower portion of the sigmoid flexure. If the colon is full of fecal matter, it is so easily felt in places that it has often been mistaken for a tumor. Therefore in case of doubtful diagnosis the colon should be thoroughly emptied before palpation.

In case of any affection of the lower portion of the abdomen examination should also be made through the rectum and vagina. It is of advantage to carry out such an examination bimanually. Diffuse peritonitis causes the anterior wall of the rectum to arch forward.

Percussion.—By percussion one may ascertain the presence of circumscribed and free peritoneal exudates, and the existence of a tympanitic area due to local or general meteorism, or to free gas. Percussion is also serviceable in mapping out the artificially distended stomach and intestine. By percussion upon the plexímeter a single distended loop of intestine may sometimes be mapped out.

If a patient whose stomach is empty stands upright and percussion shows that there is no dull area in the situation of the stomach, the greater curvature of the organ may often be determined by allowing the patient to drink one or two glasses of water. There will then be produced a well-marked area of dulness the lower border of which will correspond to the greater curvature. This dulness will disappear when the patient lies down. This test is not sufficiently reliable to serve as a determination of the size and position of the stomach unless it is confirmed by other methods of examination.

Auscultation.—Auscultation is generally of service in determining the presence or absence of intestinal gurgling. Splashing is usually heard in case of dilated and relaxed stomach. It also occurs above a stenosis of the intestine, but it may also occur in a normal stomach or in a normal intestine. Stenosis of the intestine frequently produces characteristic murmurs.

Artificial Distention.—The stomach may be artificially distended in order to show its position, size, and outline. This test is also of service in determining the site of a tumor of the stomach or some neighboring organ, and it may demonstrate possible incontinence of the pylorus.

The stomach may be distended with carbon dioxide gas by giving the patient first a teaspoonful of sodium bicarbonate and then half a teaspoonful of tartaric acid, each dissolved in 50 to 100 c.c. (3 or 4 ounces) of water. By this means the patient may be spared the unpleasant introduction of a stomach-tube. The method is somewhat questionable since it may not distend the stomach sufficiently, while in other cases the distention is too great and causes the patient pain. Indeed, such distention has been followed by rupture of a stomach which was contracted and weakened as a result of ulceration. Therefore a stomach-tube ought always to be at hand so as to relieve any possible excess in the distention of the organ. The stomach may be distended with air pumped into it after the passage of a stomach-tube. The degree of distention is then easily varied by pumping more air into the stomach or allowing some to escape.

When the stomach is thus distended, its outlines below the ribs are plainly seen, and may also be shown by percussion. Sometimes a pathological outline—for instance, that of an hour-glass stomach—can be recognized. This method of examination may fail either because the abdominal wall is well developed, or because the pylorus or cardia is incontinent, or because the patient is unable to endure sufficient distention to make the outline of the stomach clear. The stomach should never be distended in the case of recent hemorrhage or injury, and it should only be distended with great care through a stomach-tube if there is a suspicion of ulceration.

The intestine may be distended with air or water. The outline of the large intestine may thus be shown with more or less distinctness as far as the cæcum. Distention with air is simpler than that with water, and if there is a suspicious area which is dull on percussion, distention with air makes the intestine tympanitic and is therefore a greater help in diagnosis. Air more than water brings out murmur due to stenosis of the intestine. But distention with water has also certain advantages. The intracolonic pressure which is thereby produced is equal in all directions and is absolutely under the control of the operator, who can raise or lower the vessel from which the water flows, and if necessary can allow water to escape from the intestine. When air has been injected into the intestine, it does not exert everywhere an equal pressure and the pressure is less under the control of the operator. Water possesses another advantage over air in that its repeated injection breaks up fecal masses and thus permits the fluid to reach higher up in the intestine. Not infrequently it will pass the ileocæcal valve.

Intestine distended with air gives a tympanitic note on percussion, while that which is distended with water gives a dull note. Under certain circumstances one may be preferable to the other. If water is used, the quantity which can be injected is easily measured and the capacity of the intestine thereby indicated. This is not true if air is used for distention. The ampulla of the rectum holds about 0.5 litre of water (1 pint) if fully distended. As a matter of fact, contraction of its muscles will force the water either upward or downward before this quantity is injected. The rectum and sigmoid colon together hold about 1.5 litres (1.5 quarts), and the whole large intestine up to the ileocæcal valve about 3 litres (3 quarts) or even more. If this quantity is injected easily, it is fair to assume that any suspected obstruction is situated higher up. This is at best an inexact test. If the abdominal walls are for any reason contracted, water is injected with difficulty. Furthermore, the first portion of water which is injected may stimulate the muscular coat of the intestine to active contraction so that further injection is interfered with.

On account of its simplicity the injection of water is the usual method of distending the large intestine. In especial cases water should have the preference on account of safety if there is risk of perforation. It should also be used if the large intestine contains much fecal matter or if stenosis exists.

A short soft rubber tube is well lubricated and inserted into the rectum while the patient lies upon his back. There is a mistaken notion that if the tube can be inserted high up in the intestine, a greater quantity of water can be injected. The use of a long rubber tube has nothing to recommend it, for a soft tube may bend upon itself and close its own lumen, while a long stiff tube exposes the patient to the risk of perforation.

If water is employed for distention of the intestine, the pressure at which it is injected should be slight—about 20 to 50 cm. (8 to 20 inches) of water are sufficient. In rare cases 80 cm. (32 inches) may be employed. Such a pressure should only be used for a short time. For diagnostic purposes one will seldom need more than 3 litres (3 quarts) of water. This method of examination is unsuccessful if the sphincter is incontinent or very weak, as may be the case in aged individuals.

Injection of water for therapeutic purposes (colonic irrigation) is similarly carried out. This simple measure has many times sufficed to save the life of a patient, and before performing an operation for obstruction it is well for the surgeon personally to supervise its employment. One may overcome an attack of ileus in this manner after all other attempts have failed. When water is employed for therapeutic purposes even more than when it is employed for diagnostic purposes, it should be injected at a low pressure. It will often require from thirty minutes to an hour to irrigate the large intestine properly. More than 3 litres (3 quarts) may be injected, and the procedure will have to be many times repeated. If the intestine is atonic, the injection of water may be preceded by an injection of two or three spoonfuls of castor oil, which, driven up by the subsequent injection of water, may act upon the upper portion of the intestine and bring about the wished-for result. Sometimes a firmly contracted sphincter ani is found an obstacle to the complete emptying of the intestine. Under such circumstances two fingers should be introduced and separated so that the fluid may escape between them.

Examination with the Stomach-tube.—The stomach may be examined with a soft rubber tube measuring 14 mm. (0.6 inch) or less in diameter. Information thus obtained may be classified as follows: 1. The presence of stenosis of the cardia, a diagnosis which ought to be confirmed by the introduction of olive-tipped or other solid bougies. 2. The motility of the stomach. 3. The character of the gastric contents which can be removed through the tube for analysis. 4. The size of the stomach, and especially the situation of the greater curvature as shown by palpation of the end of the tube, or by the *x*-ray after the lower portion of the tube has been filled with shot. The use of the tube is counterindicated by recent gastric hemorrhage and a feeble condition of the patient from whatever cause.

The introduction of the stomach-tube if properly performed is not so dangerous a procedure as many suppose. Thus it may be employed with perfect safety in the presence of a fresh ulcer, or in the first days after

major operations upon the stomach. Indeed, in many cases of gastric hemorrhage it seems wise to introduce the tube in order to evacuate the blood and allow the stomach to contract. Certainly suspicion of an ulcer or of carcinoma cannot be considered a counterindication to the use of the tube. When the tube is in place, gastric contents may be obtained by pressure or by siphonage. It is usually unnecessary to aspirate by means of the Wulff bottle or a suction ball. Pressure may be dangerous if there is risk of hemorrhage from the stomach or other organ (lungs, brain). The quantity of fluid remaining in the stomach after it has been emptied by siphonage may be determined, according to Mathieu and Rémond, as follows: A certain quantity of water—for example, 100 c.c.—is introduced and immediately mixed with the residual fluid in the stomach by shifting the position of the patient forward and backward and from side to side. The fluid is then siphoned off and its acidity (a_1) is compared with the acidity of the gastric fluid (a) before dilution. The quantity of residual fluid in the stomach is $x = \frac{a_1.100}{a - a_1}$. In every case in which simple siphonage fails water should be injected and drawn off several times until the stomach is proved to be empty. The motor power of the stomach may be estimated by comparing the quantity of fluid in the stomach with that contained in a normal stomach under similar conditions.

Analysis of the gastric contents shows their appearance, odor, microscopical characteristics, acidity, digestive power, etc. The details of such analysis are given in text-books upon gastric diseases.

The secretion of the intestine may also be examined macroscopically and microscopically, and under certain conditions chemically. The presence of pus, blood, mucus, and fragments of tumor, evidences of delayed digestion or stenosis, biliary calculi, or other foreign bodies, are some of the results to be thus determined.

Other Methods of Examination.—In 1881 Mikulicz inspected the gastric mucous membrane with a gastroscope, an instrument similar to the cystoscope. Since that time this instrument has been improved by others, but it has not come into general use for two reasons: considerable special skill is required for its use, and a patient with suspected carcinoma in the early stages often feels so well that he will not consent to such a severe method of examination, while in the later stages the symptoms produced by carcinoma near the pylorus are sufficiently well marked to make the use of the gastroscope superfluous.

The œsophagoscope makes it possible accurately to diagnosticate carcinoma of the cardia at a time when a certain diagnosis cannot otherwise be made. Furthermore, a portion of the tumor may be removed through the instrument and submitted to microscopical examination. This method of procedure is regularly carried out in the Breslau clinic.

Illumination of the stomach by means of an electric light passed within it, and examination of the stomach by means of the x-ray are

methods which as yet have little value in connection with the early diagnosis of diseases of the stomach and intestine. The *x*-ray is a great help in the recognition of many foreign bodies in the stomach and intestine.

Rectoscopy consists in direct inspection of the rectum by means of suitable specula.

Exploratory puncture and exploratory incision as a means of diagnosis of the condition of the stomach and intestine will be described elsewhere.

THE LOCAL SYMPTOMS OF ABDOMINAL TUMORS.

The difficulty which one often experiences in determining the origin and character of an abdominal tumor makes it desirable to consider such tumors as grouped in the various regions in which they are found. For the purpose of differential diagnosis all kinds of tumors will be thus considered, and not merely tumors of the stomach and intestine.

Abdominal tumors may produce general symptoms, symptoms of disturbed function, and local symptoms.

General Symptoms.—General symptoms are due to the effect which the tumor has upon the general system. Such effects are not necessarily different from those produced by tumors in other parts of the body. Fever usually indicates an inflammatory process which in the abdomen may closely simulate a tumor, and, indeed, a tumor may produce fever either because of resorption of products of degeneration going on within the tumor or for some unknown reason. For example, malignant lymphoma, icterus, or the presence of biliary pigments in the urine indicates that the trouble is situated in the liver or biliary passages, or their neighborhood. Glycosuria suggests disease of the pancreas ; leukæmia, disease of the spleen. Emaciation with decrease of fluid in the tissues of the body suggests a tumor of the pylorus or duodenum producing stenosis. In general, tumors of the intestinal canal affect nutrition more rapidly than tumors elsewhere. The presence of indican in the urine suggests a tumor of the lower portion of the small intestine, while a tumor of the kidney may give rise to albumin or blood in the urine. This brief statement is sufficient to show how important it is to examine thoroughly the whole body whenever a diagnosis of abdominal tumor is made.

Symptoms of Disturbed Function.—Symptoms of disturbed function may be closely related to the general symptoms—for example, icterus ; or they may be confined to the particular organ affected. Sometimes a special examination is necessary to prove that disturbances of function exist. This is often the case in pyloric tumor with stagnation of the gastric contents and altered gastric juice. Peristaltic action of the intestine may be abnormal. There may be constipation or diarrhœa in case of intestinal tumor with stenosis. The urine may be altered in character or micturition disturbed in case of tumors of the kidney or bladder. Disease of the pancreas may interfere with the digestion of

fat. Interference with the portal circulation or disease of the peritoneum may produce ascites or œdema. Tumors of the uterus may give rise to irregular hemorrhage, etc. It is unnecessary to take up these various symptoms in detail since they are considered in connection with the diseases of the different organs. In some cases disease of an organ exists without producing any disturbance of function of that organ.

Local Symptoms.—The local symptoms which are shown by palpation, percussion, auscultation, and the various methods of inspection of the bladder, œsophagus, etc., by means of instruments, and also by means of the *x*-ray, give the surgeon a fair knowledge of the changes which have taken place in the affected organ. The existence of pain either spontaneous or due to pressure is a valuable symptom. Most local symptoms may exist without the presence of a palpable tumor, and, indeed, may not be due to a tumor at all. This fact renders differential diagnosis much more difficult. In the case of superficially placed tumors of considerable size the results of inspection and percussion possess a greater value. If a tumor is large, and especially if it displaces the diaphragm upward, it may be clearly shown by the *x*-ray, but in general the most valuable method of abdominal examination is palpation.

The term tumor as used in abdominal surgery signifies a palpable structure situated in any portion of the abdomen which does not conform in shape and consistence to an organ normally situated in that location. Thus, a wandering kidney may properly be spoken of as a tumor until one is absolutely certain of its true nature. Other surgeons extend the term tumor to embrace the products of acute inflammation. The difficulties of abdominal palpation are sufficient excuse for this. Thus an acute inflammation about the appendix or stomach may give the impression of a diffuse tumor; while an abscess of the liver may easily be confounded with a tumor of the liver. Such an inflammatory swelling is therefore spoken of as an inflammatory tumor. It is even difficult at times to differentiate between swelling due to marked inflammation and a new growth. For example, tuberculosis of the ileocæcal region may so closely resemble cancer of the cæcum that a diagnosis cannot be made with certainty even after the abdomen is opened. The same may be true of ulcer of the stomach, which may give rise to a swelling not to be distinguished from sarcoma until the tissue has been examined microscopically. Further illustrations are distention of the gall-bladder, retention-cyst of the pancreas, hydronephrosis, intussusception, and the so-called fecal tumor. Even a pregnant uterus has frequently been mistaken for a tumor, and has more than once led to laparotomy.

The presence or absence of fever is sometimes of no aid in distinguishing a chronic inflammatory swelling from a true new growth. Some of these inflammatory processes are not accompanied with fever, and sometimes, as stated above, new growths of the abdomen may be accompanied with fever, or they may become infected, or may ulcerate and thus produce fever secondarily.

It is naturally impossible in many cases to differentiate between a benign and a malignant tumor of the abdomen by any external examination. The size, shape, consistence, and mobility of a tumor are not sufficient data upon which to make such differentiation; while the patient may easily be mistaken in the length of time a tumor has existed, for unless it causes pain or some disturbance of function it may escape notice until it reaches a considerable size.

The term resistance also needs definition. By it is meant abnormal resistance. That is to say, the palpating finger is more impeded at a given point than it is at the surrounding points, or than it is at the corresponding point of the other side of the abdomen. Such resistance may be due to a variety of causes. The abdominal wall itself may be the seat of an inflammatory process or a diffuse new growth. The resistance may also be due to a tumor beneath the abdominal wall. This again may be a diffuse inflammation. Even a local peritonitic process which may disappear entirely in a few days may yet give while it lasts a well-marked increased resistance on palpation. Examples of this are appendicitis, perigastritis, and pericholecystitis.

Another cause of resistance which may or may not be associated with an underlying inflammatory process is contraction of a portion of the abdominal muscles. Such local contraction is an attempt of the body to protect some hypersensitive organ beneath. It is therefore a symptom of importance, but it cannot, of course, be called a tumor.

The terms tumor and resistance are not synonymous. Every tumor is a resistance, but every resistance is not a tumor. One should be careful therefore not to use the term tumor when his examination has simply shown that increased resistance exists.

Palpation alone is calculated to show two things in respect to a tumor: first, its peculiarities irrespective of its seat; and second, its position in the abdominal cavity and its relation to neighboring organs. Such relations can often be made out without moving the tumor. At other times it will be necessary to move the tumor about, and in all cases such motions should be attempted in order to establish the relation of the tumor with a greater degree of certainty. It is, of course, of the greatest importance for the surgeon to know from what organ the tumor springs.

In examining an abdominal tumor the thickness of the abdominal wall always lies between the tumor and the palpating fingers. Therefore the characteristics of the tumor are more or less obscured. Occasionally the abdominal wall is so thin and flexible, as in a woman who has borne many children, that one can feel the tumor almost as distinctly as though the abdominal cavity were open. Under ordinary circumstances, if the tumor is situated deeply in the abdominal cavity, or, wherever situated, if the muscles of the abdominal wall are contracted, palpation is very difficult. Some help will be obtained by changing the position of the patient, or by examination while the patient is lying in a warm bath, or by percussion. Still in many cases the results of examination will be far from definite, and even if the mechanical results

of palpation are sufficiently clear one may be in doubt how to interpret what he feels.

The size of a tumor is usually underestimated for the reason that the minor portion of it is accessible to the touch, while the larger part is inaccessible owing to its deep situation.

The surface of a tumor may feel smooth because it is covered with the thick abdominal wall when in reality it may have an uneven or even pebbly surface; hence one should not conclude from the results of surface palpation alone that a tumor is or is not malignant. Indeed, many malignant tumors of the abdomen, carcinoma as well as sarcoma, have a smooth surface for a long time, due to distention of the capsule and the peritoneum of the affected organ.

If the abdominal walls are lax and a tumor is movable, palpation may indicate clearly the outline of the growth. If a tumor has the normal outline of the kidney, it is probably growing in this organ. If it has a sharp lower border, it is probably of hepatic origin; whereas an oval tumor in the lower edge of which there are two or three notches is probably in the spleen. Tumors of the gall-bladder, and especially cystic tumors, are frequently pear-shaped. Tumors of the lesser curvature or pylorus of the stomach, or of the intestine, are often cylindrical or sausage-shaped. However, tumors of all organs may assume various shapes, so that too much stress must not be put upon the outline of a tumor as an indication of its origin.

Even the consistence of the tumor is determined with difficulty. A small and movable mass always gives the impression that it is harder than it really is. If a tumor is as large as a fist or larger, lies superficially, and is either firmly adherent or may be fixed by the surgeon in some situation, its consistence can be readily determined, and the presence or absence of fluctuation may also be known. Even fluctuation is at times a misleading sign, for large rapidly growing tumors may fluctuate if they are surrounded by a firm capsule. Thus the differential diagnosis between echinococcus and sarcoma of the liver, between a cyst of the pancreas and sarcoma of the retroperitoneal glands, cannot always be made even though the tumor is large and can be readily felt. The rarely occurring retroperitoneal lipoma may also fluctuate. If fluctuation is plainly present, the tumor probably springs from some organ in which cystic tumors are commonly found—for example, the liver, gall-bladder, kidney, or pancreas, but not the stomach or intestine.

A tumor of board-like consistence and ill-defined border is likely to be an infiltration of the abdominal wall itself, possibly an actinomycosis or some other inflammatory process.

If a tumor can be indented, it is probably made up of feces. Such fecal tumors occur only in the large intestine. Gersuny calls attention to a symptom of fecal tumors produced by firm pressure of the finger which he calls the "sticky symptom." When the finger is slowly removed, the mucous membrane which has been pressed against the fecal mass may be felt to pull away from it. The most definite symp-

tom of a fecal tumor is its disappearance after the repeated administration of laxatives.

Percussion of a small tumor gives no certain result. If a tumor is large and lies in contact with the anterior abdominal wall, percussion may show the existence of an area of dulness which may be merely relative if the tumor is growing from the stomach or intestine, and absolute if the tumor grows from some solid organ. Percussion is chiefly valuable as confirming the results of palpation, and as a means of examination when palpation is unsatisfactory on account of pain, muscular contraction, etc. There are rare instances of tumors and abscesses which contain gas (see page 389). Of more importance clinically is the distention of certain intestinal coils as a result of stenosis, etc. In this manner a tumor having a fairly definite outline and giving a high tympanitic note may be produced.

The movements which may be communicated to a tumor are due in part to the mobility of the organ from which it develops as well as to the character of the attachment between the tumor and such organ. A tumor which is situated within an organ and attached to it by a broad base has no mobility excepting the mobility of the organ itself, although this mobility may have been increased or diminished by the presence of a tumor. Fecal tumors have naturally a mobility independent of the organ from which they spring. The mobility may be variously altered and limited by adhesions between the tumor and other abdominal organs. These various movements may be divided into three classes: respiratory movements; movements due to distention of the hollow organs—stomach, intestine, bladder, etc.; and passive movements produced by the hands of the surgeon or by changes in posture.

Respiratory Movements.—As the ribs are lifted outward and upward during inspiration the anterior abdominal wall, and especially the upper portion of it, follows them. The descent of the diaphragm during inspiration crowds downward the abdominal organs. These two movements are in opposite directions. In thoracic breathing the effects of the former motion are more prominent, while in abdominal breathing the effects of the latter motion are more prominent. In inspiration these motions are naturally reversed.

Tumors of the abdominal wall and tumors which are adherent to the abdominal wall are so plainly affected by respiration that their movements can often be followed by the eye. Furthermore, tumors which are attached to the skin or the various subcutaneous tissues superficial to the transversalis fascia become more prominent when the abdominal muscles are contracted, while tumors of the transversalis fascia or parietal peritoneum become less prominent. All tumors of the abdominal wall in whatever layer they may be situated become fixed by muscular contraction. Such contraction is best effected by directing the patient, when lying on his back, to raise his head from the table.

Whether an abdominal tumor is affected by respiration will depend upon its distance from the diaphragm, upon its position, and upon its

consistence. The liver, from its close approximation to the diaphragm, moves more during respiration than any other abdominal organ, and as it is a compact organ its lower edge moves as much as its upper surface. Any tumor which springs from the liver or is firmly attached to it must move as much as the liver itself. This is true, for example, of tumors of the stomach if they become attached to the liver, as frequently happens. This respiratory movement of the tumor may be misleading because the liver may communicate this motion to the freely movable tumor adjacent to it, although the two have no structural connection and are not adherent. Consequently a test suggested by Minkowski is more conclusive than the mere fact that a tumor moves with respiration. This test consists in holding back a tumor during respiration. If it is impossible to do so, the tumor may safely be concluded to be firmly attached to the liver. The other organs of the epigastrium, namely, the spleen and fundus of the stomach, are less moved by respiration than the liver. As the stomach is a hollow organ the motion of its upper portion is not communicated to the lower, and the pylorus moves scarcely at all. A kidney normally situated moves with respiration, but this can be observed only in slender persons with flabby abdominal walls. If such a person is examined bimanually, the lower pole of the kidney may be felt to sink during inspiration and to rise during expiration. If this motion can be plainly felt, enlargement of the kidney may be suspected. The pancreas and retroperitoneal tumors do not move with respiration. Organs and tumors of the mesogastrium and hypogastrium are unaffected by respiration unless they extend into these regions from above.

Value of Distention of the Stomach and Intestine for Diagnostic Purposes.—The stomach and intestine are displaced in certain definite directions if they are distended; and their distention displaces to a certain degree the surrounding organs. It may be stated as a general rule that a tumor of a neighboring organ as well as a neighboring organ which, though normal, is displaced, is moved back to its proper position by the distention of an adjacent hollow organ. If the tumor is very large or if it is adherent, the motion due to distention of the stomach or intestine will be slight or altogether wanting. If there is a tumor of the organ which is distended, the motion communicated to it will differ according to the seat of the tumor.

Tumors of the anterior wall of the stomach are made prominent by distention of this organ, while those of the posterior wall are obscured. Sometimes a tumor is increased in size by the distention. Sometimes its margin is made indefinite, even though it is a tumor of the anterior wall. This is especially true of superficial tumors, which are more plainly felt when the stomach is contracted. A tumor of the stomach which feels like a single mass may separate into several portions when the stomach is distended. Tumors of the pylorus and its vicinity are displaced usually to the right and downward. If situated higher up in the lesser curvature, they are displaced to the right side; and if situated near the cardia, they disappear altogether. This is

partly due to the rotation of the stomach, which brings the greater curvature forward.

When the intestine is dilated, all tumors of the stomach are displaced upward and are usually sharply differentiated from the distended transverse colon. This intestinal distention enables one to differentiate therefore between a tumor of the pylorus or greater curvature and one of the transverse colon.

The origin of a tumor of the large intestine is often plainly shown when the intestine is distended. Such a tumor cannot be differentiated from the intestine longitudinally, and in some cases the intestine will dilate only up to the tumor. A tumor of the transverse colon is often displaced downward by distention owing to the fact that the intestine is elongated. A tumor of the transverse colon is naturally displaced downward by distention of the stomach.

A tumor of the omentum is displaced downward by distention of the stomach as well as by distention of the intestine. Distention of the intestine usually brings the tumor nearer the abdominal wall.

Tumors of the small intestine are displaced downward by distention of the stomach if they are influenced at all thereby. They are surrounded by the large intestine, and when this is distended they may be crowded downward.

Tumors of the liver, including those of the gall-bladder, are displaced upward and to the right by distention of the stomach. They are also pressed more plainly against the anterior abdominal wall. Distention of the large intestine pushes them upward and at the same time makes the lower portion of the liver somewhat more plain.

Tumors of the spleen and wandering spleen are displaced to the left and somewhat downward by distention of the stomach, while they are displaced to the left and upward by distention of the large intestine. Palpation of the spleen is thereby facilitated. Distention of the stomach is most important in those cases in which dulness due to a normal or enlarged right lobe of the liver extends into the left hypochondrium, so that it is difficult to say whether this is due to liver or spleen. The distended stomach, by pressing between these organs, will separate the dulness caused by them.

Tumors of the kidney and wandering kidney are pressed backward by distention of the stomach, and are therefore obscured. If the tumor is small, the same result follows distention of the intestine; if the tumor is larger, distention of the intestine may make it more easily palpable bimanually, while the distended colon crosses over the kidney, whether right or left, in a characteristic manner.

A tumor of the pancreas as it grows usually presses between the stomach and transverse colon; therefore when either of these organs is distended the pancreatic tumor will be more or less covered. Sometimes the pancreatic tumor appears above the lesser curvature of the stomach or below the transverse colon. In rare cases it remains behind the stomach, lifting this organ forward as it grows. If the pancreatic tumor grows retroperitoneally toward the right or left

lumbar region, it simulates a renal tumor and is obscured by distention of the stomach or intestine.

Passive Mobility.—The passive mobility of a tumor is demonstrated if the surgeon grasps it with one or both hands and attempts to move it in different directions. While this test has been applied since the earliest days of abdominal examination, it remained for Pagenstecher to make accurate tests of the mobility of various organs and tumors both in the living subject and upon the cadaver.

Every organ of the abdominal cavity has its own place to which it is more or less confined by its own attachments and the pressure of other organs. This is even true to a lesser degree of the coils of small intestine. In this respect a tumor behaves as the organ from which it grows, and a freely movable tumor has a tendency to remain in a certain situation which may be spoken of as its position of rest. Some tumors possess free passive mobility—that is, they can be moved about from the costal margin to the pelvis and from one side of the abdomen to the other. This is true of tumors of the small intestine and tumors of the mesentery if they are not situated too near the root of the mesentery, and tumors of the omentum if not too near the colon, and tumors of the ovaries or uterus which have a long pedicle. Sometimes a wandering spleen is thus freely movable, and in rare instances a wandering kidney or tumor of the pylorus. For these reasons free mobility of a tumor is not sufficient for a positive diagnosis. This is equally true of lack of mobility. Tumors of the pancreas, horseshoe kidney, retroperitoneal tumors, tumors springing from the remains of the urachus, vitello-intestinal duct, etc., cysts of the broad ligament, and inflammatory tumors which are adherent, as well as large tumors of the kidney, are usually immovable.

The determination of the area through which a tumor is movable has a certain diagnostic significance. Thus, if a tumor is pedicled and is not adherent, it will be movable through a larger or smaller circle. In most cases the attachment of the tumor is not limited to a single point; therefore the range of movement of the tumor is sometimes a circle, sometimes an oval, and sometimes a segment of a circle, etc. The centre of the area in which motion is possible represents the point of fixation, which may be the fixation of the organ in which the tumor is situated or the fixation of a pedicled tumor to some organ.

Different portions of the stomach possess different degrees of mobility, that of the pylorus being the greatest. The greater curvature is also very movable, but it is rarely the seat of a primary tumor. The area of mobility of tumors springing from these parts is usually a large circle or an oval. A tumor of the lesser curvature can be moved through a small oval similar to that of the gall-bladder though situated on the left side. A tumor of the fundus or the cardia may or may not appear below the border of the ribs. If so, this movement is limited to a slight up-and-down motion.

A tumor of the cæcum or ascending colon may be moved through an area which is arched toward the left side. The central point is rep-

resented by the fixation of the cæcum. A tumor of the descending or sigmoid colon may be moved through the corresponding area of the left side of the abdomen, but as the sigmoid mesocolon varies greatly in length, the mobility of a tumor of the sigmoid also varies. Sometimes a tumor of the transverse colon is freely movable, but in most cases there is a limit to its motion downward as well as toward either side. A tumor of the omentum is more movable the farther it is situated from the colon. The free mobility of the small intestine and mesentery has been mentioned. An enlarged gall-bladder partakes of the respiratory movement of the liver, but is otherwise not movable with the organ, rather in the opposite direction. The area of mobility may be an oval or a circle, or it may be confined to a line or a shallow arch in the frontal plane.

A wandering spleen is movable on the left side, and perhaps beyond the median line. If its degree of mobility is slight, it may be confounded with a wandering kidney. It can usually be recognized by its characteristic shape and its relation to the distended colon. It lies in front of the colon, while the kidney lies behind it.

The degree of mobility of a wandering kidney varies. Pagenstecher mentions three grades. A kidney of the first grade of mobility is palpable below the costal margin and can be pushed upward. A kidney of the second grade moves about its point of attachment, toward which the hilus is always directed. A kidney of the third grade of mobility can be displaced to the opposite side of the vertebral column. A tumor of the kidney usually displaces the organ downward, and if adhesions do not prevent it, may be pushed upward. In rare instances a tumor of the kidney possesses a greater degree of mobility.

The area of mobility of an ovarian tumor is often limited above by a shallow arch whose centre is situated in the true pelvis. Tumors which spring from the female pelvic organs when pressed upward by the hand upon the abdomen usually exert a distinct pull upon the cervix uteri which can be recognized by a finger in the vagina. This sign is wanting if the tumor has a long, slender pedicle.

A tumor of the abdominal wall can be moved about if the abdominal wall is relaxed. When its muscles are contracted, the tumor becomes fixed.

A tumor moves with changes in position of the body, usually sinking toward the lowest portion of the abdomen. Such movement is always less than the maximum passive motion. A foreign body in the stomach may be displaced from one portion to another of the organ by changes in the position of the patient. A wandering kidney often becomes more prominent when the patient lies upon the side or stands or kneels. A tumor of the true pelvis may fall forward and upward if the patient rests upon the knees and elbows or if the pelvis is elevated. These positions of the patient may also displace a vesical calculus from some hidden position to the vertex of the bladder, making it palpable externally or accessible to the sound.

The results of palpation of tumors of the abdomen, and especially

of the tests of their mobility, often depend upon the relaxation of the abdominal wall, and also upon the proximity of the tumor to the abdominal wall. It is therefore of advantage, as previously mentioned, to examine patients in different positions; such as the half-reclining position, with knees flexed and supported, or the knee-chest position, or with the pelvis elevated. The position of the patient should be such as to bring the organ in question as much as possible out of the hidden situation. In examining the lumbar region for suggested tumor of the kidney a patient should lie upon the sound side, while a sand-bag or firm cushion is placed beneath the unaffected loin. In this manner the ribs and ilium of the affected side are separated and the parts are rendered more accessible for examination. Examination of the epigastric and mesogastric regions is facilitated by a cushion placed beneath the lumbar vertebra while the patient lies in dorsal decubitus.

Relaxation of the abdominal muscles is facilitated if the patient breathes not too strongly with his mouth open. The surgeon should also distract the attention of the patient by conversation. Some surgeons anæsthetize a patient in order to relax the abdominal muscles, but Mikulicz has not done so for many years. There may be instances in gynecological practice in which the anæsthetic is desirable in order to spare the patient the pain and discomfort of an examination. In difficult cases an examination should be made while the patient is in a warm bath, since the abdominal muscles are greatly relaxed thereby.

The results of examination of abdominal tumors are much more striking if they are arranged in tabular form, or marked upon a diagram in different colors. The examination should show:

1. The condition of rest, the area in which pain is felt, the results of palpation, inspection, percussion, and the position of normal organs as well as that of the tumor.
2. Respiratory motions.
3. The limits of the greatest passive mobility of the tumor.
4. The results of distention of the stomach and intestine.

CHAPTER XIII.

MALFORMATIONS OF THE STOMACH AND INTESTINE.

CONGENITAL ANOMALIES OF THE STOMACH.

The only malformation of the stomach which possesses surgical interest is pyloric stenosis. This may be slight or severe. Sometimes the stenosis is a true contraction of the orifice, and sometimes it is due to hypertrophy of the circular muscles. This hypertrophy may be so extreme that the wall of the pylorus measures 1 cm. (0.4 inch) in thickness, and the pylorus is palpable as a small tumor. This condition is quite different from complete atresia of the pylorus.

Neurath collected reports of 35 cases of congenital pyloric stenosis in which autopsy was performed. The symptoms appear either soon after birth or during the first year of life. They are similar to the symptoms produced by pyloric stenosis in later life except that the stomach does not have time to reach a high degree of dilatation before the child dies. There is intense vomiting of material which is free from bile, whereas ordinary infantile vomiting if severe is bilious. Sometimes peristaltic action of the stomach is visible, and sometimes a pyloric tumor may be felt. Under such circumstances the diagnosis is easily made. The passage of a stomach-tube will show that the motor function of the stomach is disturbed. There will be no hyperacidity as long as the child takes nothing but milk.

It is not possible to determine whether mechanical stenosis or muscular spasm exists. In the latter case internal treatment may be continued, but not too long, since so young a child sinks rapidly if the vomiting continues. The results of recent operations for this trouble are encouraging. Trautenroth collected reports of 12 cases treated by operation (1 pyloroplasty, 2 pyloric divulsions, and 9 gastro-enterostomies). Seven children survived operation.

There is another form of pyloric stenosis in which the symptoms are not manifest until some years after birth. Such stenosis may be a simple narrowing of the lumen of the bowel, or it may be of a hypertrophic character. In the present state of our knowledge it is impossible to say whether such stenosis is congenital or acquired.

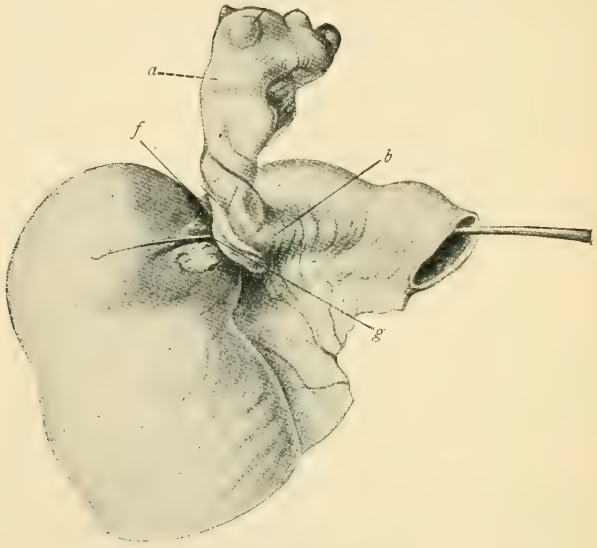
There is also a congenital stenosis of the stomach itself (hour-glass stomach); or a transverse partition of the stomach may exist.

MECKEL'S DIVERTICULUM.

The commonest congenital anomaly of the intestine is known as Meckel's diverticulum. It is described as a form of incomplete obliteration of the vitello-intestinal duct. (Page 139.) Meckel's diverticulum is found in about 2 per cent. of subjects, according to English

anatomists. It is a blind appendage of the lower portion of the ileum. It is attached in adults from 50 to 60 cm. (20 to 24 inches) above the ileocæcal valve, although the point of attachment varies from 30 to 130 cm. (12 to 52 inches). It is usually opposite the mesentery. Its tip may be free or united to the umbilicus by a solid cord. It varies much in length and diameter, and in shape may be cylindrical, conical, or club-shaped. At the point where it joins the small intestine there is usually a valve.

FIG. 67.



Obstruction and perforation of the intestine by a twist of *a*, Meckel's diverticulum; *b*, its insertion into the intestine; *f*, gangrenous wall of intestine; *g*, perforation through which a probe is passed. (Hilgenreiner.)

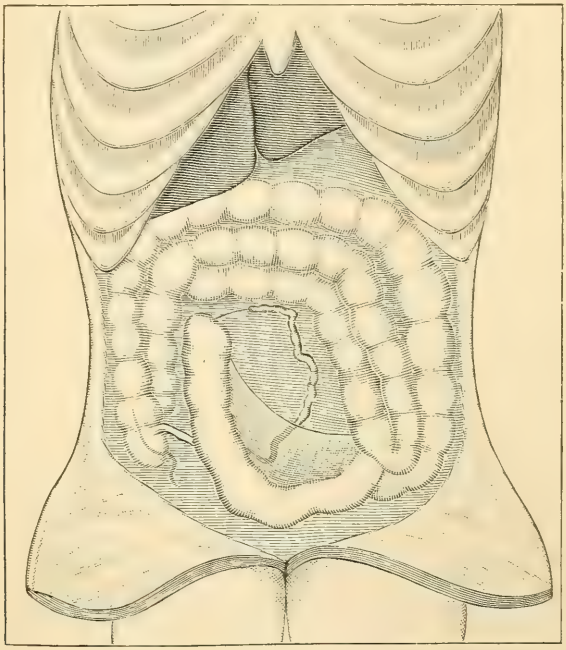
Under certain circumstances Meckel's diverticulum becomes of clinical importance: 1. It may enter a hernial sac. If it becomes strangulated, it will give rise to the usual symptoms of strangulated hernia. 2. It may produce ileus by acting as a band to obstruct a coil of intestine. 3. A foreign body may lodge in it. 4. It may be the seat of an attack of inflammation similar to inflammation of the vermiform appendix. Such attacks could only be differentiated if the diverticulum and appendix were widely separated. It is, however, to be borne in mind that the location of the cæcum itself is somewhat variable.

When Meckel's diverticulum is found to be the seat or source of disease, it should be removed in the same manner as the appendix vermiformis. If it is found accidentally during operation and its condition is not such as to suggest future trouble, it should not be disturbed. The removal of this diverticulum is a simple operation. It lumen is closed at the base by a purse-string suture. (See page 401.) Only in rare cases in which the lumen is large is it necessary to close the gap in the intestinal wall by a double row of transverse stitches.

CONGENITAL STENOSIS AND DISPLACEMENT OF THE INTESTINE.

Any portion of the intestine may be congenitally absent or its lumen may be wanting. This is especially true of the anus and rectum. Gärtner, who in 1883 collected reports of 65 cases, exclusive of rectal affections, found that the most common seat of atresia is in the neighborhood of the attachment of the vitello-intestinal duct. (Fig. 68.)

Fig. 68.



Congenital occlusion of 15 cm. (6 inches) of ileum. (Martens.)

Atresia of the duodenum is somewhat less frequent. The seat of the trouble in the duodenum is usually above the papilla of Vater. If the papilla itself is involved, the biliary and pancreatic ducts may be distended so as to form large cysts.

The large intestine is seldom the seat of congenital stenosis. Sometimes the sigmoid flexure is found bent at such a sharp angle as to interfere with the passage of feces. This produces secondary hypertrophy and dilatation. Stenosis in different portions of the intestine may coexist.

The symptoms due to congenital intestinal stenosis are similar to those of acquired stenosis in the same portion of the intestine. (See page 295.) If the lumen is nearly or completely occluded, surgical treatment alone can be of benefit. The operation may be either a plastic one or an anastomosis, or the establishment of a fecal fistula.

As far as known, all the patients operated upon have died except those suffering from obstruction due to a kink of the sigmoid flexure. This condition has been successfully relieved by the establishment of drainage through the anus.

The intestine or a portion of it may be congenitally misplaced, or it may be abnormally long or abnormally short. These abnormalities of themselves do not produce serious symptoms, but they may predispose to volvulus, etc. They may also lead the operator into mistakes in diagnosis.

Complete situs inversus is a well-recognized anomaly. There are also partial degrees of the same malformation. Thus the small intestine may be situated on the left side and the large intestine on the right, or this relation may be reversed; or the large intestine may be situated behind the small intestine so that the transverse colon lies between the duodenum and the vertebral column.

The cæcum may be abnormally long and variously misplaced. Under such circumstances the appendix is also misplaced. The transverse colon may be elongated so as to form a V, and it may even have more than one loop. The same is true to a still higher degree of the sigmoid colon. Such conditions predispose to volvulus. The ascending colon may be wanting, so that the cæcum joins the hepatic flexure; or the cæcum may be wanting and its site be marked by a rudimentary appendix. Other portions of the large intestine may also be absent.

An abnormal length of the whole intestine is sometimes attributed to a coarse vegetable diet during the period of most rapid growth.

The mesentery of the upper portion of the jejunum may be wanting, so that this small intestine is as closely attached to the posterior abdominal wall as is the duodenum. The lower portion of the ileum may present the same condition. The ascending or descending colon may have so complete a mesocolon as to resemble the small intestine. The muscular bands of the colon may be continued in the wall of the ileum. Portions of the intestine may be double and variously connected with one another.

ACQUIRED INTESTINAL DIVERTICULA.

There are intestinal diverticula which are said to be acquired, although their origin is somewhat in doubt. They may occur singly or in small number, or they may occur in large number—four hundred or more. They may be of any size up to that of an apple. These diverticula if small possess no surgical interest. They may be either true—that is, involving all layers of the intestinal wall; or false, in which case the muscular layer is not involved, but the mucous membrane projects through an opening in it like a hernial sac. Congenital diverticula are of the true type, while those which are acquired are for the most part false. Acquired diverticula may be due to ulceration, foreign bodies, constipation, or external traction the result of adhesions or

tumors. A diverticulum is prone to form in some portion of the intestinal wall which is weak on account of the presence of a vein or other vessel, or the biliary or pancreatic ducts.

Small diverticula usually give rise to no symptoms. They may, however, lead to chronic inflammation of the submucosa and subserosa, and may even set up adhesions between the intestine and surrounding parts. Such a condition is easily mistaken for a tumor. Larger diverticula may compress some portion of the intestine or interfere with the function of other abdominal organs. Fecal concretions may form in them, and they may also give rise to ulceration and adhesions or perforation into the peritoneal cavity.

CHAPTER XIV.

INJURIES OF THE STOMACH AND INTESTINE.

SUBCUTANEOUS INJURIES OF THE STOMACH AND INTESTINE.

Injuries of the stomach and intestine have so much in common that it is better to consider them together. Indeed it is frequently impossible to make a differential diagnosis between the two. And the important point to determine is not which portion of the alimentary tract has been injured, but does or does not an injury of the alimentary tract exist. Subcutaneous injury of the stomach or intestine is usually the result of some force acting directly upon the abdomen, though in rare instances it may be produced by a violent jarring of the whole body. Some of the commoner injuries are a kick from a horse, the passage of a wagon-wheel over the abdomen, a blow from a fist or with a ball, a crush between railroad cars, a fall on a sharp angle or upon water. In rare cases a violent contraction of the abdominal muscles may result in rupture of a healthy stomach.

The trauma may be diffuse or circumscribed. The force usually strikes the abdominal wall in the immediate neighborhood of the organ which it injures, but this is not always the case. For example, a blow in the hypogastrium may rupture the stomach situated in the epigastrium. In rare instances force which is not applied directly to the abdomen may injure some abdominal organ. An example of this is a fall upon the feet. Such an injury is apt to be associated with intra-abdominal hemorrhage.

Injuries of the abdominal wall have been considered elsewhere. The lesions here considered may be classified under three heads:

1. Rupture of an organ which is more or less full of gas or fluid.
2. Tearing of an organ from its attachments.
3. Contusions.

The two first kinds of injury are due to stretching of the organ beyond the limit of its elasticity. The stomach usually ruptures along its lesser curvature, and the intestine at some point oposite the mesenterial attachment, whereas if the organ is torn it is almost always in the neighborhood of its attachment. This lesion is almost never seen in connection with the stomach. Parts of the intestine most often torn are the junction of the duodenum and jejunum and the ileocæcal region.

A contusion is either the result of a circumscribed force—for example, a kick; or it occurs when the injured organ is pressed against some unyielding part of the body, such as the vertebral column or the pelvic bones. The latter is the usual form of injury. In most cases

the organ is injured in two opposite places which have been pressed together.

Subcutaneous injuries are not equally common in all portions of the abdomen for the reason that the anatomical relations of organs, their relative fixation, distention, etc., play an important part in their injury or escape from injury. The stomach is protected by the ribs and is relatively seldom ruptured. Petry collected records of 219 subcutaneous injuries of the alimentary canal, and found that the stomach was involved 21 times, the small intestine 172 times (duodenum 9 times, jejunum 46 times, ileum 85 times), and the large intestine 26 times (cæcum 7 times, ascending colon 8 times, transverse colon 4 times, descending colon 2 times, sigmoid 5 times).

Rupture is relatively more frequent in old individuals than in young ones.

Injury of the stomach or intestine may be of different degrees of severity. The lesions may be divided into contusions, non-perforating injury, and perforations.

A contusion is usually the result of crushing, rarely of overstretching of the intestinal wall. It may be so slight that there is no hemorrhage, or so severe that it leads to necrosis and subsequent perforation. A slight contusion heals without a scar, the extravasated blood being resorbed. Hemorrhage occurs most often in the submucosa. It may loosen the mucous membrane for a considerable distance and by depriving it of nourishment cause it to necrose. As a result of such injury as much as 150 cm. of intestinal mucous membrane has been known to pass per rectum. Interstitial hemorrhage is not always followed by necrosis of the mucous membrane. Traumatic ulcer due to necrosis of the mucous membrane will be considered in a subsequent chapter.

A contused area may be marked by minute hemorrhages, or an extensive diffuse hemorrhage which shows the characteristic colors of degenerated blood, or the affected portion may show the black color of necrosis.

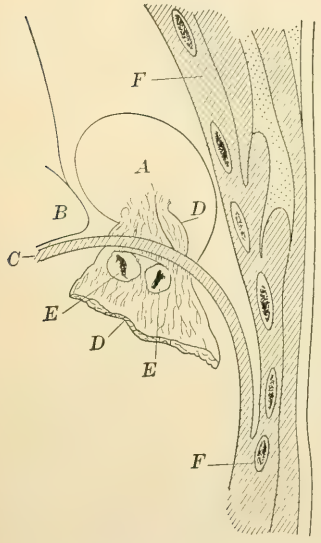
Non-perforating injuries may be of the nature of contusions, or they may be partial ruptures due to increased tension within the organ, or in rare instances to tension from without. These tears are generally fairly straight and have smooth edges. But there are so many variations in the appearance of both contused and torn wounds that it is impossible to say from the appearance of the part how the injury was produced. The mucous membrane may be alone affected, or the mucous membrane and muscular coats, or the muscular and serous coats, or the serous coat alone. Injuries of the mucous membrane may be superficial or deep, and may open small or large vessels. It is rare that the serosa is the only coat injured, although this may be true even of circular wounds which extend throughout the circumference of the bowel.

If the muscular coat is torn, there is separation of the edges of the wound. If the serous and muscular coats are both torn, the mucous

membrane projects in the form of a hernia which will subsequently increase in most cases.

Perforation may be due to rupture from increased tension or tearing or crushing. A perforated wound due to crushing may have smooth edges. Such a wound may follow the kick of a horse. The immediate effect of a perforating wound is contraction of the muscular coat, which after about six hours is followed by paralysis. The loose mucous membrane crowds into the wound, so that if the perforation is small the membrane may block it completely and prevent the escape of intestinal contents. Larger openings gap and allow feces to escape. Even if the small intestine is torn clear across, contraction of the circular muscles will often close its lumen for a short time and prevent the escape of its contents. Soon, however, the mucous membrane projects and holds the lumen open.

FIG. 69.



Strangulation of the stomach through a rent in the diaphragm; *A*, hernial sac in the pleural cavity; *B*, pericardium; *C*, diaphragm; *D*, omentum passing through the diaphragm, together with *E*, cut transverse colon; *F*, chest-wall. (Mackenzie and Battle.)

In the first hours after injury it is impossible to differentiate between perforating and non-perforating injuries of the stomach and intestine. The later symptoms of these two classes of injuries and their outcome are widely different.

Non-perforating Injuries.—Little is known of the exact conditions of non-perforating injuries of the stomach, since for the most part they heal spontaneously. Unless the patient dies of injury of some other portion of the body so that an autopsy is performed, the diagnosis remains a probable one. Even if an ulcer develops later, the condition of the stomach immediately after the injury can only be surmised. In Petry's collection of 24 cases of subcutaneous injury of the stomach 4 were classed as contusions with recovery in every instance. In 2 instances injury led to an ulcer which was recovered from, and in 2 instances the resulting stricture of the pylorus was relieved by operation. A rare result of non-perforating injury of the stomach is shown in Fig. 69.

The immediate effect of a traumatism of the stomach, whether perforating or not, is shock. This may, of course, be due to injury of any other abdominal organ, or even to injury of the abdominal wall. The injury of the stomach itself may produce no further symptoms, or it may cause pain, vomiting, and hemorrhage. Of course, every tear of the mucous membrane of the stomach no matter how slight produces some hemorrhage, but if the quantity of blood is small it will not be vomited and may pass unnoticed in the stool. Moreover,

contusions and injuries of the intestine, as well as injuries of the abdomen without traumatism of the stomach or intestine, may be followed by gastric hemorrhage.

Symptoms.—The late symptoms of injury of the mucous membrane without perforation are due to the ulcer which follows. In rare cases an abscess forms in the gastric wall, or it becomes the seat of diffuse inflammation. Contusions and non-perforating wounds may lead to necrosis and secondary perforation.

Treatment.—The treatment of non-perforating wounds of the stomach is purely symptomatic. The treatment of hemorrhage is exactly that of a fresh gastric ulcer. The stomach is protected as much as possible. Pain is to be controlled by an ice-bag upon the abdomen. Narcotics should be withheld for a few hours lest they obscure the differential diagnosis between perforating and non-perforating wounds.

Perforating Injuries of the Stomach.—Perforating injuries of the stomach, for the most part of the nature of rupture, are usually found in the lesser curvature near the pylorus, but less often in the neighborhood of the cardia, and less often still in the anterior wall. The rupture is generally longitudinal. Usually some other organ is injured—for example, the liver, spleen, or pancreas. Rupture of the stomach has in several instances followed a slight traumatism such as violent contraction of the abdominal muscles. Such an accident is more likely to occur in an individual who has been drinking. Furthermore, if the gastric wall is weak in any point as a result of an ulcer or cicatrix, perforation will be more likely to follow a comparatively slight injury.

Symptoms.—The symptoms of rupture of the stomach or intestine are sufficiently characteristic. They are: 1, well-marked shock; 2, local symptoms referable to the perforation; 3, symptoms due to the effect of perforation on the general peritoneal cavity. If the patient does not lose consciousness, he complains of intense pain, most marked in a limited area at the site of perforation. In rare cases the patient is not much affected by the rupture and walks or rides for miles. Usually shock appears in a short time, and the senses are dulled possibly to a degree of coma, or the patient may become exhausted. There is pallor, with sunken countenance, a small, irregular, and frequent, or in rare instances very slow pulse. Respiration is frequent and irregular, perhaps of the Cheyne-Stokes type. The skin is cool and the body temperature is less than normal. The patient may die in shock as the result of cardiac paralysis. This is, however, rare unless the injury is extensive. Usually the first shock passes over, the patient's senses return, and his pulse and appearance improve.

The intense localized pain continues. It is not much increased by pressure, but there is little characteristic about it. There is usually vomiting. This is relatively more frequent after perforation of the intestine than after perforation of the stomach, perhaps because the gastric contents escape more readily into the peritoneal cavity. The

vomitus may be bloody. According to Angerer, repeated bilious vomiting indicates a perforation of the stomach, while non-perforating wounds are followed by only one or two attacks of vomiting. Eructations and nausea are also present.

The abdominal muscles are soon firmly contracted, and may be as hard as a board so that the abdomen is hollow. If this symptom continues for hours, the probability of perforation of the stomach or intestine is great. The cremaster muscle is also strongly contracted, according to Trendelenburg. The abdominal walls are frequently hyperæsthetic. Respiration is thoracic.

Sooner or later symptoms appear which are due to the escape of gastric or intestinal contents into the peritoneal cavity. Gas rises to the portion of the abdomen which is uppermost, while fluid seeks the lowest portion. Whether or not these differences are well marked will depend upon the quantity of escaped fluid and gas. As the patient lies upon his back the highest point of the abdominal cavity is in the middle of the epigastrium. Even a small quantity of free gas may be demonstrated here, since it will replace the normal hepatic dulness by a circumscribed area of tympanitic resonance. Percussion with a hammer upon a pleximeter produces a metallic clang. A larger collection of gas obscures the whole area of hepatic dulness.

Escaped fluid gives the usual symptoms of free fluid in the peritoneal cavity. Dulness in the most dependent portion changes with change in the position of the patient. Seigel says that the dulness first appears on the side on which perforation is situated. As the fluid and gas increase the previously sunken abdominal wall becomes distended and the condition changes to that of perforative peritonitis or to that of peritoneal sepsis. The abdomen becomes more and more distended as the result of the formation of gas in the paralyzed intestine and as the result of increased peritoneal secretion. The abdomen is everywhere tender, the pulse becomes smaller, more rapid and softer, and there is an increase of temperature. The patient is collapsed, and hiccough and vomiting ensue. The urine is scanty or secretion is suppressed as the result of reflex action upon the kidneys. If present, it contains albumin and indican. There is no movement of the bowels or passage of gas per anum. Bloody stools indicate a non-perforating injury of the mucous membrane. In brief, the symptoms of peritonitis develop which are given in detail in Chapter X. of this volume, continuing with more or less intensity until death.

While the group of symptoms above given is sufficiently characteristic, the diagnosis in certain cases is difficult. Shock may not be present and the patient may express himself as feeling well. On the other hand, shock may be due to traumatism without injury of the abdominal organs. The initial pain is never wanting, but may be due to simple injury of the abdominal wall. Moty advises letting the patient drink water, which if perforation exists will cause a sudden increase of pain. This test seems dangerous and has been seldom applied.

Vomiting is first seen in non-perforating injuries of the alimentary tract and may be wanting after perforation. Blood in the vomitus or in the stools is not a reliable sign of perforation. Even the signs of free fluid in the abdominal cavity may be due to profuse hemorrhage, and the early symptoms of abdominal injury which lead to such a hemorrhage may be the same as those of rupture of the stomach or intestine. Usually, however, hemorrhage may be known by the acute and rapidly increasing anæmia. Even here one may be mistaken, for acute peritoneal sepsis following perforation may produce a small rapid pulse, pallor, rapid respiration, and subnormal temperature, symptoms similar to those seen in acute anæmia. Dulness due to the presence of free fluid is not usually observed unless the quantity of such fluid is considerable. The most important single symptom is therefore the presence of gas in the peritoneal cavity, but this is not always easy to determine. A high degree of meteorism may by turning the liver backward cause the area of hepatic dulness to disappear, or distended coils of intestine may come to lie between it and the anterior abdominal wall. On the other hand, perforation may be present without alteration of the area of hepatic dulness.

Schmidt emphasizes the importance of a well-marked tone of tympanitic resonance directly over the perforation. Gluzinski says that when there is free gas in the peritoneal cavity the cardiac and respiratory sounds can be heard more plainly than usual. Adamson and Crawford have heard a tinkling sound in the obstructed region synchronous with the heart or with respiration ; but this sound has also been heard in cases of marked gastric dilatation. Senn distends the stomach or intestine with hydrogen gas. If the abdominal cavity is opened, the escape of gas can be observed ; if the abdominal cavity is closed and perforation is present, free gas will collect in the highest part of the abdomen and obscure the hepatic dulness. This test is dangerous and should not be tried except when laparotomy is to be immediately performed. Mikulicz in one case obtained combustible gas from the peritoneal cavity by aspiration in a case of rupture of the stomach occurring during an alcoholic debauch. In rare cases subcutaneous emphysema follows the escape of gas into the peritoneal cavity. In many cases one must be content with a diagnosis of rupture of some portion of the alimentary canal. Indeed, such a diagnosis is satisfactory, since the subsequent treatment is practically the same in all cases. Rupture of the stomach or large intestine is usually followed by less violent symptoms than rupture of the small intestine. Gastric contents are less rich in virulent bacteria, and the contents of the large intestine owing to their solidity do not so readily escape. Vomiting of blood indicates injury to the stomach. Simple vomiting is in no wise characteristic.

Diagnosis.—In making a differential diagnosis of perforation, the character and the seat of injury are of importance. A lesser injury may serve to rupture the stomach, especially if it is overloaded. A given force is more likely to produce perforation if the object which

comes in contact with the abdominal wall is rather sharp. The condition of the abdominal wall is also important, since a relaxed and thin wall gives the abdominal organs less protection than a firm and thick wall.

The period of shock may pass directly into one of peritonitis, or the symptoms of perforative peritonitis may develop without a previous period of shock.

If the patient recovers from the traumatism, and after an interval comparatively free from symptoms the signs of perforation develop, the condition is spoken of as late perforation. Such a delay in the symptoms may be due to temporary closure of the perforation by prolapsed mucous membrane aided by an empty condition of the organ and contraction of its muscles, or escape of contents may have been temporarily prevented by fibrinous adhesions to the neighboring peritoneal surface. Still another cause of late perforation is necrosis of the wall of the organ following contusion. Perforation of this sort takes place at the end of the first or the beginning of the second week.

Perforation is not always followed by escape of gastric or intestinal contents. If the conditions are particularly favorable, peritoneal adhesions may close the opening and lead to spontaneous cure. Such adhesions may also give way after weeks and allow peritonitis to develop. Perforation may also take place in an isolated portion of the peritoneal cavity, and the abscess thus formed may later break into the intestine or into the general peritoneal cavity, or the pleura, or through the abdominal wall, or its contents may be resorbed in the course of weeks or months. Finally, rupture may take place at some point not covered by peritoneum and lead to the development of cellulitis or a retroperitoneal fecal abscess. This is especially true of rupture of the ascending or descending colon or the duodenum.

Even when gastric or intestinal contents escape into the general peritoneal cavity the symptoms may be comparatively mild. Such a favorable course of the trouble indicates that the ruptured organ was empty and contained few virulent bacteria. If adhesions follow, they may close the perforation and the patient recover; or, as is more likely, a circumscribed peritonitis develops about the perforation and gradually spreads throughout the general peritoneal cavity in the form of fibrinopurulent peritonitis. The course and symptoms of different forms of peritonitis are described elsewhere in this volume.

Prognosis.—The prognosis of rupture of the stomach or intestine is very unfavorable if operation is not performed. There is no question that some patients recover spontaneously. One should not forget, however, that a patient whose perforation is closed by a limited fibrinous peritonitis is in the greatest danger until the healing processes are complete. In many of the cases which have been reported as instances of spontaneous recovery the diagnosis of rupture of the stomach or intestine is an extremely doubtful one. The symptoms described might equally as well have been due to a contusion or other non-perforating injury. Without autopsy it is difficult to say positively in these mild

cases that a perforation existed. Such a diagnosis is far more difficult to make than is the diagnosis of perforation due to simple gastric ulcer, for in the latter case the symptoms are not obscured by those due to traumatism. Spontaneous recovery may also follow perforation due to ulcer, but here too such a fortunate outcome is extremely rare.

The results of operation are relatively good. Petry found 44.5 per cent. of recoveries among 18 patients operated upon within twenty-four hours of rupture, and 25 per cent. of recoveries among 24 patients operated upon more than one day after rupture.

Treatment.—The treatment of acute perforation of the stomach or intestine should therefore be by operation. This should be performed as early as possible—before peritonitis has time to develop. But even if the patient is not seen until some time has elapsed, operation is still indicated as giving him a slight chance of recovery, while without operation the outcome is almost certain death. Lahoda saved a patient by operation eighty hours after traumatic rupture of the stomach although intense peritonitis had already developed. The rule ought to be therefore to open the abdomen, even though peritonitis is present, if the patient's general condition is such that he can endure operation.

There are two objections to early operation, namely, the uncertainty of diagnosis and the possible existence of shock. The surgeon may be mistaken in assuming that an intraperitoneal hemorrhage is a perforation; but this mistake is of comparatively little practical importance, since either condition should be treated by operation. A more serious error is to mistake for a rupture a simple contusion or other non-perforating lesion, especially of the mucous membrane. In doubtful cases a positive diagnosis cannot be made until the appearance of peritonitic symptoms. If one waits for these, the most favorable time for operation will have passed. Hence it is better to operate when a probable diagnosis of perforation can be made. A small incision will suffice to confirm or reject such a probable diagnosis, and will not subject the patient to much risk.

It is advisable to wait until the first intense shock has abated. If the shock does not diminish in a few hours or if it increases, one may fairly assume that it is not due to traumatism alone, but rather to commencing peritonitis, since, as stated above, the shock of traumatism may pass directly into that of peritonitis. If such be the case, operation by combating the cause of the shock will be the best treatment for it. Anæsthesia is not counterindicated by existing shock, and indeed the patient's condition often improves after administration of the anæsthetic.

If the diagnosis is uncertain and the stomach is known to be empty, it is safe to wait for twelve hours before opening the abdomen. Such a patient should be carefully watched. If no symptoms of peritonitis develop within twenty-four or forty hours, the operation should be postponed. This expectant treatment is also allowable if a well-localized peritonitis develops a day or more after the injury. If operation is performed in the intermediate stage of such a condition, there will be risk of infecting the general peritoneal cavity, while if the patient

is let alone the localized peritonitis may pass away of itself when the peritoneum has resorbed a small quantity of pus and gastric contents, or it may lead to a circumscribed abscess which can be opened at a later date.

Operation is performed as follows: If it is certain that the stomach is ruptured, the incision is made in the epigastrium. If the site of the perforation is unknown, a hypogastric incision is preferable. The existence of perforation is usually recognized as soon as the peritoneal cavity is opened, from the escape of free gas or the presence of gastric or intestinal contents. Gastric contents may be recognized by their appearance and odor and acid reaction. Eichberg says that the liver and spleen take on a bluish-gray color from even a small amount of free gas in the peritoneal cavity. This sign may be of value in doubtful cases. Senn's use of hydrogen gas in the presence of perforation has already been spoken of. If operation is performed more than twelve hours after perforation, there will usually be found well-marked signs of peritonitis which will guide the operator to a perforation.

If the diagnosis of perforation is made, the exploratory incision is carried upward—in case of the stomach even to the ensiform cartilage. One should not hesitate to give himself the benefit of the widest incision so that the inspection and cleansing of the peritoneal cavity may be thorough. A perforation in the anterior wall of the stomach is easily found. One in the neighborhood of the cardia is seen with difficulty. It is necessary to divide the gastrocolic ligament or the lesser omentum in order to explore the posterior wall of the stomach unless a rent in the anterior wall of the organ enables the operator to examine its posterior wall from within its cavity. As soon as the perforation is found it should be surrounded with a temporary tamponade, as described on page 213. An opening in the stomach should be closed by two rows of sutures. It is not necessary to trim the edges of the wound unless they are badly bruised. The best indication that tissue is in good condition is the fact that it bleeds freely when cut. When the perforation has been closed, the peritoneal cavity should be cleansed. If gastric or intestinal contents have escaped, a considerable portion of the peritoneal cavity will usually have been soiled and a thorough cleansing can only be obtained by irrigation. A hot (40° C., 104° F.) 1 per cent. sterile salt solution is best for this purpose. Every nook of the whole peritoneal cavity from the diaphragm to Douglas's pouch should be irrigated. Fortunately this irrigation tends to overcome the symptoms of collapse. A large quantity of fluid is required—from 20 to 40 litres (quarts). If the means for such thorough irrigation are not at hand, it is better not to irrigate at all, but to wipe the peritoneal cavity with gauze moistened with hot sterile salt solution or even with dry sterile gauze. An imperfect irrigation is worse than none because it tends to spread the infectious material throughout the peritoneal cavity. The abdominal cavity should be closed except in cases of well-marked peritonitis, when a Mikulicz tampon or Rehn tube for

irrigation (pages 177 and 219) may be employed. Closure of the peritoneal cavity even in cases of peritonitis is rendered possible by the thorough irrigation spoken of above. The treatment of advanced peritonitis is described in Chapter X.

Sometimes the surgeon fails to find the perforation either on account of its median situation or because the general condition of the patient does not permit of a protracted search. Sometimes the perforation when found cannot be closed for similar reasons. In such cases the region of the perforation should be treated by tampons.

After operation the patient should be kept absolutely quiet and for two or three days should receive nothing by mouth, not even water. Fluid should be given by rectal injections, and if these do not succeed in quenching his thirst subcutaneous injection of saline solution should also be administered. In three or four days the administration of fluid by mouth can be commenced and the diet regulated according to the principles given on page 224. The alimentary tract may be kept quiet by the administration of opium, and in addition morphine in case the pain is severe. It is better not to give narcotics until the diagnosis is made with certainty, but when this has been done there is no objection to their administration. Narcotics should not be given when perforation is suspected but for one reason or another operation is delayed. Moreover, in these doubtful cases the diet and other treatment of the patient ought to be as carefully regulated as when perforation is known to exist.

The question has been raised whether a patient supposed to have suffered from perforation of the stomach or intestine ought to be transported to a hospital. This is in general inadvisable, but if it has to be done it is far less injurious in the first hours after the injury than at a later period. On the other hand, it must be remembered that laparotomy for the purpose of finding and closing a perforation of the stomach and intestine is a difficult operation which cannot be carried out successfully unless there are reasonably good facilities. Therefore, there are many cases in which it is better to take the risk of transportation rather than the greater risk of operating in unsuitable surroundings.

PUNCTURING WOUNDS OF THE ABDOMEN WITH INJURIES OF THE STOMACH OR INTESTINE.

Injuries of the abdomen which lead to opening of the peritoneal cavity are spoken of as puncturing or perforating wounds. They are usually accompanied with injury of some abdominal organ. They may be caused by some sharp object, as a stick, or horn, or dagger, or by firearms. Gunshot-wounds of the abdomen constitute about 6 per cent. of all gunshot-wounds. Stab-wounds of the abdomen form a far less percentage of all stab-wounds. Whether an abdominal organ is injured depends largely upon the surface which it presents. In case of the stomach this varies greatly with its distention. The probability of injury of an abdominal organ also rests upon the shape and size of

the instrument and the force with which it strikes against the abdominal wall. The stomach and intestine are not so likely to be injured by dull objects as by sharp ones, and they are less likely to be injured by a bullet of lesser velocity than by one of great velocity. However, instances are known in which bullets of the highest velocity have passed clear through the abdomen without injuring the intestine.

According to Fischer's army statistics, the intestine was injured in 60.9 per cent. of gunshot-wounds of the abdomen, the liver in 16 per cent., the stomach in 7.4 per cent., the spleen in 2.7 per cent., and the pancreas in 0.4 per cent. Siegel collected records of 225 cases of puncturing gunshot- and stab-wounds of the abdomen, and found that 33.3 per cent. were of the stomach, 28.5 per cent. of the duodenum, 16.5 per cent. of the liver, 11.6 per cent. of the large intestine, 7.1 per cent. of the spleen and kidneys, and 7.1 per cent. of other organs. In 146 cases collected from German literature of gunshot injuries received in time of peace the traumatism was distributed as follows: 19 per cent. to the abdominal wall alone, 28 per cent. to the small intestine, 24 per cent. to the liver, 24 per cent. to the stomach, 19 per cent. to the large intestine, 12.3 per cent. to the spleen, 0.2 per cent. to the pancreas, 0.13 per cent. to the gall-bladder. In these figures every injury is counted, so that cases in which more than one organ was injured appear more than once.

From these and similar statistics it is clearly shown that the probability of internal injury in perforating wounds of the abdomen is extremely great. The probability, according to Siegel, is as high as 30 to 1. Tautzscher says that puncturing stab-wounds are more frequently uncomplicated than puncturing gunshot-wounds. There is also a difference in the frequency with which the stomach is wounded in times of peace and war, which may perhaps rest upon the fact that the stomach is more often empty in times of war than it is in times of peace.

If the puncturing wound is a large one, and even if it is not so large, the abdominal organs may prolapse through it. The omentum is the organ which is most frequently found in a wound. Such a prolapsed organ is not necessarily injured, or, if the organ which is prolapsed is injured, one must not assume that other organs are not also injured. The pleural cavity may also be opened in a puncturing wound of the abdomen. Coexisting injury of the stomach or intestine is almost always a perforation. If the wall is not completely perforated, the injury is usually confined to the serous or the serous and muscular coats. As such injuries have already been described (p. 255) they will not be further considered here. A stab-wound usually produces a single opening in the stomach, and a bullet two—one of entrance and one of exit. Other organs are more likely to be injured at the same time in the case of gunshot-wounds than in the case of stab-wounds. In stab-wounds the size of the opening corresponds more or less to the instrument by which it is caused and the edges of the wound are sharp. The perforation in a gunshot-wound corre-

sponds more or less to the size of the missile, but it may be much greater, especially in the case of the stomach and intestine. In exceptional circumstances it may be considerably smaller than the projectile which has caused it. The more nearly the projectile strikes the wall of the organ at a right angle the smaller will be the wound. The character of the wound depends also upon the kind of projectile and the rapidity with which it passes through the body. In general the wound of entrance of the stomach or intestine is smaller than the wound of exit, but differences in the angle which the stomach-wall presents to the course of the projectile make exceptions to this rule. The opening may be a smooth round one or irregularly torn. The edges of the wound are often contused, especially if the shot has passed obliquely. The mucous membrane projects into the wound, and may even occlude a small wound. This closure, according to Klemm's experiments upon animals, can only take place in case the perforation is less than 0.5 cm. (0.2 inch) in diameter.

Symptoms.—The symptoms of a penetrating wound of the stomach or intestine are essentially the same as those of subcutaneous perforation plus symptoms due to the wound in the abdominal wall and possibly prolapse of abdominal organs. The diagnosis is often evident. Under certain circumstances it may be extremely difficult. Sometimes it is not easy to say whether a wound is a perforating wound; and even if it is not a perforating wound it may be accompanied with rupture of the stomach or intestine just as the latter may occur without wound of the abdominal wall. Such a complication is more likely to exist if the abdominal wound is caused by a blunt instrument than it is in stab- and gunshot-wounds.

It is just as important to watch the patient after a penetrating wound of the abdomen as when subcutaneous rupture of the stomach or intestine is suspected. Vomiting of blood and intra-abdominal hemorrhage are symptoms more often seen after penetrating wounds than after subcutaneous rupture. Such hemorrhage due to the rupture of a large abdominal vessel or to an injury of the mesentery may produce both local symptoms and severe general anæmia.

In rare cases a wound in the intestine will present itself in the wound in the abdominal wall and discharge the intestinal contents externally without soiling the peritoneum. In other rare cases fluid which has been discharged from the stomach or intestine into the peritoneal cavity will find its way out through the abdominal wound. But such evidences of internal injury are rare. If the abdominal wound is small, it contracts and is filled with a blood-clot or is stopped by the omentum. From the character of the injury, the direction of the projectile or instrument, and the shape of the wound itself one may draw a conclusion as to the probable injury of abdominal organs, but such conclusions are merely guesses. Experience has shown that with rare exceptions every penetrating wound of the abdomen is complicated by injury of some abdominal organ. The surgeon ought to be guided by this fact in his treatment of the patient.

Prognosis.—The prognosis of an untreated perforating wound of the abdomen is even less favorable than that of subcutaneous injury. Death follows from perforative peritonitis or from hemorrhage. Fatal hemorrhage usually comes, not from some vessel of the stomach or intestine, but from some vessel of the mesentery, or from one of the large abdominal vessels. A case which appears in the beginning favorable may terminate fatally on account of the separation of protecting adhesions. This is spoken of in the section on subcutaneous rupture. Late perforation may also be due to injury of the mesentery with secondary gangrene of the corresponding portion of intestine. Fistula of the stomach or intestine follows perforating wounds of these organs more frequently than it follows subcutaneous rupture. Such a fistula may lead to death by starvation.

There is considerable difference between the outcome of gunshot-wounds of the abdomen received in peace and those received in war. For example, statistics of the Anglo-Boer War collected by Treves and others show that only about 40 per cent. of those who received gunshot-wounds of the abdomen and were not operated upon died. Possibly a few of these patients did not suffer from perforation of the stomach or intestine. A serious criticism of these figures is made by Hildebrandt, who points out that only those patients were counted who came under the care of the surgeon, while no account is made of those who died on the battlefield from such injuries or during transportation. If these were also counted, the percentage of mortality of gunshot-wounds of the abdomen not treated by operation would be at least 70 per cent. The fact that so many patients recovered after this severe injury may be due in part to the general emptiness of the alimentary canal in this war, and in part to the fact that most of the bullets were of small calibre. At any rate, the mortality of the patients not operated upon was less than that of the patients treated by operation, most of whom died. It must be admitted, however, that the conditions of the war were unfavorable to operation. The patients had frequently to be transported great distances, a considerable time elapsed between the injury and the operation, and hygienic necessities were difficult to obtain.

According to Makins, the prognosis of a gunshot-wound of the abdomen associated with perforation of the alimentary canal depends a good deal on the direction taken by the bullet. The most dangerous wounds are those which pass through the abdomen in the frontal plane, while the next in point of severity are those which strike the small intestine in the sagittal plane. Bullets which pass through the abdomen obliquely are less likely to produce death since they usually wound the colon instead of the small intestine. Even wounds which perforate both the thoracic and abdominal cavities, or the pelvic and abdominal cavities, are less dangerous than those of the character first mentioned. Makins also calls attention to the relative frequency of wounds involving both the thoracic and abdominal cavities (30 per cent. in this war). This may possibly be due to the fact

that much fighting was done with men in the recumbent or nearly recumbent position.

Makins says that mortality is greatest after perforation of the transverse colon and small intestine on account of the free motility of these parts, while it is less after perforation of the ascending colon and rectum. Mortality after perforation of the stomach, sigmoid flexure, and descending colon falls between these two extremes.

Haga reports a mortality of 77.1 per cent. following gunshot-wounds of the abdomen in his division in the recent Japanese-Chinese War: 40 of these patients died on the battlefield and 33 afterward. Rostowzew reports a mortality of 24 per cent. after operative treatment of gunshot-wounds of the stomach and a mortality of 23 per cent. after the same injury treated without operation. These were in civil life. Ziegler's statistics show a mortality of 46 per cent. following non-operative treatment of 30 abdominal stab-wounds between the years 1876 and 1890; 22 such wounds were treated between 1891 and 1897 with a mortality of 18 per cent. Siegel's statistics include all sorts of perforating abdominal wounds without reference to the abdominal organ which was injured. They show that 532 patients were treated without operation with 55 per cent. of mortality, and 376 patients were treated with operation with 52 per cent. of mortality. He has included, however, under the head of operative treatment all operations whether early or late, but here, just as in subcutaneous rupture, the time of operation is most important. Thus in the same class of cases the mortality after operation performed within four hours is only 15 per cent., while that after operation performed from five to eight hours after injury is 48 per cent., that between nine and twelve hours 64 per cent., and that after operations performed still later is 70 per cent. The mortality after early operation for stab-wounds is only 8.7 per cent. for operations performed within the first twenty-four hours.

Statistics as well as experiments upon animals show beyond a doubt that the chance of spontaneous recovery is considerably better after perforating wounds of the stomach than of the intestine. Hence a differential diagnosis between these two injuries is of practical importance. Unfortunately this can rarely be made unless characteristic fluid escapes from the abdominal wound or there is hemorrhage from the stomach. Even then the intestine as well as the stomach may be wounded. Perhaps in a few cases the situation and duration of the wound may enable the surgeon to make a correct diagnosis.

Treatment.—The treatment of penetrating wounds of the stomach or intestine is purely operative, at least in times of peace. The object of the surgeon should be to find at the earliest possible moment the opening or openings in the stomach or intestine and to close them by suture. Unfortunately this cannot always be done either because the diagnosis is uncertain or for some other reason. If the diagnosis is reasonably certain and the conditions are favorable for laparotomy, it ought to be performed at once. Even in doubtful cases if the conditions for a proper performance of laparotomy exist, an exploratory in-

cision exposes the patient to far less risk than a purely expectant treatment. On the other hand, to open the abdomen when the conditions for successful laparotomy are not at hand will often lessen the patient's chances of recovery.

Whether gunshot-wounds of the abdomen can be successfully treated in war is at least doubtful. The army surgeon will rarely have an opportunity to operate at the most favorable period—that is, within a few hours after receipt of the injury. Furthermore, the conditions for operation cannot be as satisfactory as in time of peace. In view of the further facts shown by the last war, that many patients not treated by operation recovered, and that the prognosis without operation was considerably better than after operation, the rule at the present time for the army surgeon should be to treat such cases expectantly. There are other things in connection with the treatment which greatly affect the prognosis in the case. The ideal treatment of such a patient would be to erect a tent over him and not to remove him for at least three or four days until the openings in the stomach or intestine were closed by peritoneal adhesions. If this plan is impossible, he should be carried the shortest possible distance. Wherever he can have rest, whether in a hut or a palace, his chance for recovery is equally good.

Whether these patients in time of peace should be treated by laparotomy even after peritonitis has manifested itself, is still a disputed question. For answer the reader is referred to the section on Operative Treatment of Peritonitis.

If a patient with penetrating wound of the stomach or intestine is treated expectantly, absolute rest of the body, and especially of the affected organ, is all-important. This implies the withholding of all nourishment by mouth, and the use of opium, etc. In every case treated, however, the wound of the abdominal wall and prolapsed abdominal organ should be closed, prolapsed omentum should be ligated, cut off, and the stump replaced. If there is prolapsed and wounded stomach or intestine, it is to be repaired and replaced, and the external wound drained by a tampon of iodoform gauze. Torn or contused wounds of the abdominal wall should be treated in an antiseptic manner so as to prevent infection, which may spread inward. As long as laparotomy is under consideration the canal of a gunshot-wound had better not be disturbed. A superficial cleansing and antiseptic dressing are sufficient.

Operative treatment is carried out as follows: If it is not apparent whether the wound opens the peritoneal cavity, it should be enlarged in order to determine this point. Such wounds should not be probed on account of the risk of introducing infection within the peritoneal cavity or loosening adhesions. If the peritoneal cavity is opened and perforation of the alimentary canal is suspected, an incision should be made in the median line. This is the most favorable place from which to examine and cleanse the abdomen. If, however, the nature of the injury makes it certain that the lesions are found to one side, a lateral incision may be chosen. A median incision

is in all cases preferable for wounds of the stomach, and if necessary it can be enlarged by a transverse incision. If the wound through the abdominal wall is near the median line, the incision may be made through it. If the wound into the abdomen is large, examination should first be made through it and the surgeon guided thereby in determining subsequent operation.

When an injury of the stomach or intestine has been found, search should still be made for other injuries of the alimentary canal or of other organs. Attention should especially be directed to the possible rupture of large vessels, such as those of the mesentery, greater and lesser omentum, mesocolon, etc.

Perforation of the stomach should be closed by a double row of sutures. The edges of a gunshot-wound are frequently contused and torn, so that it will be necessary to cut them away and so to trim the wound that it can be closed by a linear suture.

If the wound in the abdominal wall is ragged or dirty, it should be suitably cleansed and drained. The question of closure of the abdominal cavity and of after-treatment is discussed under Rupture of the Stomach. (See page 261.)

INJURIES OF THE DUODENUM.

The various traumatisms described in the preceding sections may occur in the duodenum. Subcutaneous injuries of the duodenum are relatively more frequent than penetrating wounds on account of the firm attachment of the organ to the vertebral column, and on account of its protected position. For this reason it is very likely to be pressed against the vertebral column and injured by a blow. Contusion rarely leads to serious injury, and most non-perforating subcutaneous injuries are not diagnosticated. They may, however, lead to ulcer or stenosis. If the injury affects the orifice of the common bile-duct, stenosis of this duct may also result.

Among the perforating subcutaneous injuries are to be named total rupture of the duodenum. In 3 such cases Jeannel found the intestine torn across near the pylorus and in 2 it was torn across at the juncture of the duodenum and jejunum. The reason why it was severed in these two places is obviously the fact that they are places in which the movable portion of the canal is joined to the fixed portion. Partial rupture may occur in any portion of the duodenum, but chiefly in its lower portion. The anterior wall was 14 times affected in such injuries, while the posterior wall was only 6 times affected. In only 1 of these 20 cases was the line of rupture parallel to the axis of the bowel. The length of rupture varied from a slight tear to one involving two-thirds of the circumference. In some of these cases other portions of the intestine were simultaneously injured.

If the duodenum is opened either as an immediate or a late result of an injury, its contents need not necessarily enter the peritoneal cavity, since a part of its wall is not covered by the peritoneum. This

was true of 5 of the 6 cases of injury of the posterior wall above referred to. There will follow in such a case a retroperitoneal gangrenous inflammation which will ultimately lead to peritonitis. If the rupture leads into the peritoneal cavity, the result will be perforating peritonitis.

Symptoms.—The symptoms of injury of the duodenum closely resemble those of injury of the stomach. Pain is felt more on the right side than on the left, while vomiting of blood and gastric contents occurs in less than half of the cases. The symptoms due to perforation into the peritoneal cavity are exactly like those of perforation of the stomach. If there is retroperitoneal perforation, the symptoms are at first obscure, consisting of continuous pain and extreme sensitiveness in the region of the duodenum, fever, and a more or less rapid development of a septic condition.

The diagnosis may remain obscure for several days or until the patient dies either before or after peritonitis develops.

Treatment.—The treatment of contusion of the duodenum is the same as that of contusion of the stomach. The treatment of rupture is purely operative. Two patients having rupture have been treated by laparotomy and cured, while 3 others who were operated upon and all the patients who were not operated upon have died. No patient with retroperitoneal rupture has yet been operated upon.

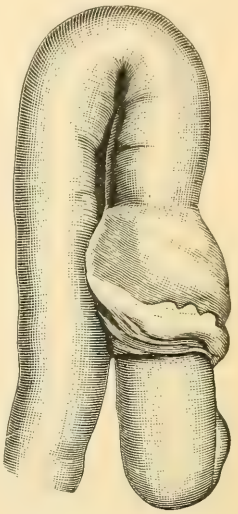
Wiart says that in operating upon retroperitoneal rupture it is better to proceed laterally from the ascending colon, instead of making the operation from behind without opening the peritoneum. But a better plan is to make a median incision in order to come directly upon the ruptured organ whether it is a retroperitoneal or an intraperitoneal one. The diagnosis in such cases is at best an uncertain one, and the first step in the operation should be to make it exact, and this can be better done from in front than from behind. If it should be found that the rupture is retroperitoneal, the field of operation can be protected by a temporary tamponade. If the conditions are such that a perfect closure of the intestine cannot be secured and there is probability that the patient will recover with a large duodenal fistula in case the wound is tamponed, it is better to avoid the risk of suppuration by performing gastro-enterostomy or jejunostomy. If an intraperitoneal rupture is satisfactorily sutured, gauze drainage will be unnecessary. This should, however, be employed for a retroperitoneal rupture.

INJURIES OF THE SMALL INTESTINE.

Subcutaneous injuries of the small intestine may result from overdistention, crushing, or jarring. The bowel is most likely to be torn from its attachments at its junction with the duodenum or with the cæcum. If the intestine is ruptured by increased tension from within, the wound is situated opposite to the mesenteric attachment. Contusions may occur in any portion of the intestine. Puncturing wounds of the small intestine are usually multiple. This is particularly true

of gunshot-wounds, of which a dozen or more may exist. The appearance of the wound and the effects of the same have been considered in preceding sections. Rupture of the intestine within a hernial sac is discussed under Hernia. Subcutaneous rupture of the intestine if treated by conservative methods generally terminates fatally (149 of 160 cases), according to Petry. If the patient escapes death, it is due to adhesion of the omentum to the wound, and recovery is usually not complete until the fecal abscess has discharged spontaneously or has been opened. Death is due to intraperitoneal hemorrhage in about 10 per cent. of the cases, and a few patients die from late perforation, but the chief cause of death is a rapidly spreading peritonitis. Reports in 28 cases of contusion of the intestine show that 12 patients died from the injury and 16 recovered, 3 of them after the passage of a gangrenous section of intestine. This occurs from one to two weeks after the injury. If necrotic mucous membrane is discharged from the bowel, the diagnosis is absolutely certain, otherwise unless the patient comes to autopsy it is merely a probable one. Four patients recovered from the immediate effects of the injury, but died of cicatricial stenosis.

FIG. 70.



Intestine of a dog four weeks after removal of its muscular coats. The dilated portion is that operated upon; adherent omentum is shown at its lower margin. (Schloffer.)

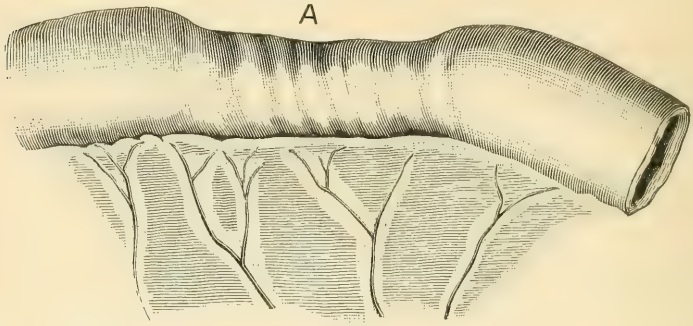
Treatment.—The treatment of perforation of the small intestine is purely operative whether the rupture is of a subcutaneous character or is due to a puncturing wound. The small openings in the intestine should be sutured either with or without excision of the edges of the wound. The line of suture should be transverse in order to avoid stenosis. If the injury is extensive or if several punctures exist close to one another, circular resection should be performed, and the ends of the bowel brought together by suture or by a Murphy button.

Poppert resected intestine in 5 places for 12 perforations the result of a pistol-shot, and saved his patient. Many instances have been reported in which success has followed the removal of long portions of small intestine, but it is dangerous to resect more than 2 metres (6.5 feet).

The treatment of contusion of the intestine is generally an internal one similar to that of contusion of the stomach. If a laparotomy is performed and only a slight contusion of the intestine is found, it may safely be left alone. If the contusion is so severe that perforation may follow, the damaged bowel should be resected and sutured. In doubtful cases one may suture over the injured portion without previous resection. It has also been recommended to stitch the omentum or neighboring coils of intestine to such an injured spot in

order to guarantee its vitality or to prevent the perforation, if such occurs, from opening into the peritoneal cavity. Non-perforating

Fig. 71.



Intestine of a dog four weeks after crushing: A, the portion crushed is constricted. (Schloffer.)

injury of the intestine may lead to dilatation or constriction (Figs. 70 and 71).

INJURIES OF THE MESENTERY.

Injury of the mesentery requires especial attention because it may threaten the vitality of the intestine. Such injury may be either a contusion, ecchymosis, hæmatoma, or perforating or non-perforating wound. A non-perforating injury involves only one layer of the mesentery. These injuries carry with them the double risk of hemorrhage and loss of nutrition to the corresponding intestine.

A puncturing wound may involve any portion of the mesentery. Subcutaneous injury may result in a cross-tear of the intestine together with the mesentery. In some instances two such tears exist, so that a portion of the intestine with its mesentery is completely separated from the rest of the alimentary canal. The intestine was torn away from its mesentery for a distance of 75 cm. (30 inches) in a case mentioned by Bulteau.

Diagnosis.—The diagnosis of injury of the mesentery can only be surmised before opening the abdomen. The indications for laparotomy are symptoms such as have been described as following injury to other abdominal organs. If the mesentery alone is injured, hemorrhage may produce acute anæmia, or there may be signs of disturbed nutrition of the intestine, such as bloody stools, ileus, or beginning peritonitis (see the section on Embolism and Thrombosis of the Mesenteric Vessels).

Treatment.—Wounds in the mesentery should be sutured lest they lead to incarceration of intestine. Bleeding vessels should be ligated, and if the injury is such as to threaten the vitality of a portion of intestine the latter should be resected. The appearance of the bowel will usually show whether its blood-supply is interfered with. In cases

of doubt it is better to resect the bowel, especially if it also is injured. Under such circumstances a circular resection is less dangerous than suture of the intestinal wound. The technic of these operations is described on pages 468 *et seq.*

INJURIES OF THE LARGE INTESTINE AND OMENTUM.

Subcutaneous injuries of the large intestine are almost always due to rupture or contusion. What has been said on the subject of injuries of the stomach and small intestine is for the most part applicable to injuries of the large intestine. The large intestine is, however, peculiar in that a considerable portion of it is not covered by peritoneum, and injuries of this portion do not directly affect the peritoneal cavity. In this respect the large intestine is like the duodenum. Extraperitoneal rupture of the large intestine is, however, extremely rare. Other characteristics of the large intestine are its thick fecal contents and the virulence of its bacteria, its relative immobility, and its slow peristalsis which favors adhesions. The great virulence of the bacteria in the large intestine adds to the risk of perforating wounds. The wall of the large intestine is thin and does not readily contract so as to block up small wounds, and yet the slow peristaltic action and solidity of the intestinal contents may save the patient from an escape of fecal matter. The conservative treatment of wounds of the large intestine gives equally good or better results than conservative treatment of wounds of the small intestine. Still, if the diagnosis can be made with some probability the treatment should invariably be operative when the perforation is into the peritoneal cavity or behind the peritoneum.

On account of the situation of the omentum immediately behind the anterior abdominal wall it is often injured in penetrating wounds, and it frequently protrudes through wounds of the abdominal wall. In such cases the protruding omentum should be ligated and cut away and its stump cleansed and replaced. Wounds in the omentum may give rise to considerable hemorrhage. Such wounds usually occur in connection with wounds of other organs which give more prominent symptoms than the wounds of the omentum. Subcutaneous injury of the omentum may be accompanied with hemorrhage or a tear may extend completely across the omentum. Injuries of the mesocolon and lesser omentum are spoken of in connection with those of the mesentery.

INJURIES OF THE STOMACH FROM WITHIN.

Injuries of the stomach from within are chiefly of the nature of burns, although the organ is sometimes injured by foreign bodies. The introduction of a sound often produces superficial injuries, such as the tearing off of a bit of mucous membrane, but such lesions heal quickly. Orth, however, mentions a case in which the patient died of gastric

hemorrhage. The use of a stiff sound—for example, an œsophageal sound—has led to perforation of the stomach into the peritoneal cavity at a point in the greater curvature opposite the cardia. Such a patient might be saved from perforative peritonitis by a prompt laparotomy and suture of the gastric wound. In doubtful cases the patient should be treated exactly as a patient in whom the diagnosis of rupture of the stomach is doubtful.

The caustics which so injure the stomach that surgical aid is demanded are the mineral acids, such as hydrochloric, nitric, and sulphuric acids, and the alkalies, such as potassic or sodic or ammonic hydrate. Oxalic acid, carbolic acid, corrosive sublimate, zinc chloride, and other substances may also cauterize the mucous membrane of the stomach, but the poisonous action of such substances is so prompt that surgical relief is seldom called for on account of their caustic action.

The concentration of the substance swallowed is relatively more important than its quantity. It is also important to know whether the stomach was empty or full. Burns of the stomach are almost invariably associated with those of the mouth and œsophagus. The parts of the stomach especially affected are the upper portion of the lesser curvature and the pylorus. Fluid which passes from the œsophagus into the stomach first comes into contact with the lesser curvature. (See Fig. 123, page 408.) The moment the caustic touches the stomach its muscles contract violently from the cardia to the pylorus and the caustic flows along the lesser curvature to strike against the pylorus. If a great quantity of caustic is swallowed, the whole inner surface of the stomach may be burned.

In rare cases the caustic may pass the pylorus and exert its action upon the small intestine for a short distance.

The effect of the caustic varies in degree from a slight hyperæmia to complete necrosis or even rupture. The sloughs produced are grayish or white and brittle and dry. Nitric acid stains the tissue yellow, and weak caustics stain it brownish or violet. Tissues burned by alkalies are less brittle than those burned by acids. In some instances the caustic burns a hole through the stomach and exerts its action upon neighboring organs such as the liver, spleen, and pancreas. If the caustic action is not strong enough to cause immediate destruction of tissue, hemorrhagic inflammation follows. Thus a necrotic area will be surrounded by a zone of brownish or greenish or blackish tissue. If the patient lives, the dead tissue separates from the living and is cast off.

The first effects of the caustic are intense pain, which is greatly increased by the slightest pressure, thirst and vomiting. In severe cases the vomitus contains blood and shreds of mucous membrane. There is more or less shock, which in severe cases may terminate in speedy death. If perforation results, general or local peritonitis may follow.

Slight burns are followed by perfect repair and deeper ones may be recovered from with a scar. If the cicatricial tissue is very extensive,

it may lead to contraction of the stomach of a marked degree, with atrophy of the whole mucous membrane. Scars of the pylorus often produce stenosis, while scars of the lesser curvature may produce the so-called hour-glass stomach. The ulcer following a burn may refuse to heal and become chronic.

Treatment.—The first step in the treatment should be to stop the caustic action of the material which has been swallowed. Thus if an acid is swallowed, the patient should quickly drink some alkali, such as magnesia, chalk, or milk. Alkalies in the form of carbonates are less serviceable on account of the development of carbonic acid gas. If an alkali has been swallowed, the patient should be given vinegar, acetic acid, or lime-juice. In any case the strength of the caustic can be diluted by water or other indifferent fluids. On account of the risk of perforation, the stomach-tube, if used at all, should be introduced with the greatest caution. If the caustic has poisonous properties as well as caustic ones—for example, carbolic acid or corrosive sublimate—the washing out of the stomach is less dangerous and more important. The subsequent treatment in mild burns is purely internal, similar to that employed in ulcer of the stomach.

Surgical treatment may be demanded in the following cases: 1. In perforation and peritonitis an immediate laparotomy and tamponade may be necessary. Suture of a recent perforation due to caustic is scarcely practicable. 2. If a considerable portion of the stomach is cauterized, it may be necessary to eliminate it until it has time to heal. Several successful jejunostomies performed for this purpose have been reported. If the ulcer has already cicatrized with stricture, a gastro-enterostomy is usually indicated. If only the œsophagus is burned, gastrostomy would naturally be performed rather than jejunostomy. 3. If the cicatrix leads to stenosis of the pylorus, pyloroplasty or gastro-enterostomy is indicated; and if it leads to hour-glass stomach, gastroplasty or gastro-anastomosis may be successful in restoring the normal relations of the parts, or gastro-enterostomy may be necessary. 4. If only the lesser curvature or the cardiac portion of the stomach is burned, gastrostomy is indicated. A burn in this locality often produces stenosis of the cardia, which may be treated by bougies passed through the mouth or passed through the gastric fistula.

Some surgeons do not believe that the healthy stomach ruptures spontaneously. In the cases of this accident which have been reported the stomach was probably the seat of an ulcer or burn or a scar. The treatment of spontaneous rupture, if it occurs, is similar to that of traumatic rupture or that of a perforative ulcer.

CHAPTER XV.

INFLAMMATORY DISORDERS OF THE STOMACH AND INTESTINE.

FOREIGN BODIES IN THE STOMACH.

Most foreign bodies which enter the stomach reach it through the mouth and œsophagus. They may be swallowed intentionally by hysterical or insane patients, criminals, or suicides; or they may be swallowed accidentally, especially by children. The objects thus swallowed, such as needles, nails, coins, natural and artificial teeth, bones, bits of glass, beads, stones, rings, pieces of wood, knives, forks, spoons, scissors, etc., present the greatest varieties of size and shape. An article which passes through the pharynx beyond the reach of the finger may stick in the œsophagus or it may enter the stomach. This will depend upon its size and other characteristics. Relatively large bodies which possess no sharp angles may dilate the œsophagus and pass through it; while a smaller foreign body which is pointed or has a sharp corner may catch in the wall of the œsophagus. If a pin is swallowed head first, it invariably reaches the stomach. If it passes point first, it may stick in the wall of the œsophagus, but even then food which is afterward swallowed may swing its head into the current, drag its point loose from the œsophageal wall, and carry it into the stomach. Objects with two sharp points, like larger needles, fish-bones, etc., are not so easily passed, and they frequently lead to perforation either of the œsophagus or some other part of the alimentary canal. The subject of foreign bodies in the œsophagus is discussed at length on page 34.

In a few cases foreign bodies enter the stomach through the pylorus. Thus a gall-stone may perforate from the common duct or gall-bladder into the upper portion of the duodenum, and if the lumen of the duodenum is obstructed by swelling, it may be easier for the stone to pass into the stomach than to pass downward; or such a stone may remain fixed in the pylorus. Round worms may enter the stomach through the pylorus.

Sharp objects, chiefly needles, may pass directly into the stomach through the abdominal and gastric walls. Bullets may reach the stomach directly. The point of a knife may break off in it or a Murphy button used for gastro-enterostomy may fall backward into its cavity. (Page 407.)

A foreign body may develop within the stomach itself. Such a body may be formed of human or animal hairs which are swallowed in small amounts and are gradually rolled up into a ball. Schopf refers

to 16 cases of this character chiefly occurring in young girls that were in the habit of chewing the ends of their hair. (Fig. 72.) Similar balls have been found composed of the fibres of plants, or of shellac.

Symptoms.—The effect of a foreign body depends upon its size and other characteristics. A small body causes no trouble unless it is sharp.

FIG. 72.

Hair cast removed from human stomach (½ natural size). (Jacobson.)

A needle may perforate the stomach and pass into the peritoneal cavity or into the intestine or bladder, or some large vessel, without giving rise to symptoms of gastric perforation. Otto had a patient who swallowed 395 needles in a period of three years. They appeared in almost all portions of the body.

Larger objects which remain for a long time in the stomach may set up inflammation and ulceration with the various consequences of these lesions, such as adhesion, perigastritis, abscess, fistula, etc. But it has frequently happened that some large object or several such objects will remain for a long time in the stomach without giving rise to serious symptoms. This applies not only to lunatics, but also to artists and other individuals that unconsciously swallow small foreign objects.

While a foreign body in the stomach may produce no symptoms, it may also produce a feeling of weight or pain or nausea or loss of appetite. It may produce necrosis and thus cause the various symptoms of ulceration, perforation, etc. Sometimes the foreign body can be felt through the abdominal wall, especially if it is large or caught in the injured wall of the stomach. A ball of hair or fibres of plants gives the impression of an extraordinarily movable tumor which changes its position with the movements of the patient and in certain positions disappears altogether. Such a foreign body has been mistaken for a tumor of the stomach or for movable kidney or for a movable spleen. In suspected cases it is well to distend the stomach with air in order to demonstrate that the foreign body moves freely in the cavity of the organ. Sometimes it may be seen to move with peristaltic action.

A foreign body in the stomach may produce nervous symptoms not only in sensitive or hysterical patients, but also in those who were perfectly well before the foreign body was swallowed. It is also worth mentioning that neurotic and insane persons sometimes say that they feel a foreign body in the stomach when none is there. They usually claim that some small animal has been swallowed and has been moving around in the stomach. It is well to remember that in rare instances small animals have been swallowed and have been found in the stomach.

Diagnosis.—The diagnosis of a foreign body in the stomach may be an extremely difficult one. The œsophagoscope will show whether a foreign body has lodged in the œsophagus. One can demonstrate the presence of metallic and some other foreign bodies by means of the *x*-ray, and can follow them through the alimentary canal. Aside from these two means, the diagnosis of foreign bodies in the stomach rests upon more or less uncertain symptoms.

Small foreign bodies may be ejected from the stomach during vomiting. This is frequently the case with round worms. Small objects which are not vomited, even if they are pointed, usually pass through the pylorus sooner or later and escape through the rectum. The time which elapses between the entrance of the foreign body into the stomach and its passage through the pylorus varies from a few hours to many weeks or months.

Even large objects, such as forks, spoons, etc., may pass through the pylorus and ultimately leave the body through the rectum. Block mentions that in a period of eight months the following objects passed through the rectum of an insane patient: 157 broken pieces of glass, the longest measuring 5 cm. (2 inches), 102 pins, 150 rusty iron nails, 3 hairpins, 15 broken fragments of iron, a large piece of lead, half of a shoe-buckle, and 3 small hooks. The foreign body may become wedged in the pylorus, although this is rare. An object is more likely to become fixed in some other portion of the intestine. If a foreign body becomes wedged in the pylorus, it sets up the usual symptoms of pyloric stenosis.

Treatment.—If the presence of the foreign body in the stomach is

established, treatment will depend upon the character of such a body, and at a later period upon the symptoms which it produces. If the object is not likely to injure the pylorus or the intestine, it should be left alone. Its passage through the natural channels is facilitated by keeping the patient upon a diet of potatoes, rice, gruel, peas, beans, etc., and avoiding the administration of laxatives. Such treatment is particularly important in case the foreign object has sharp points. If no complication is present, it is better not to give opium. If there are symptoms which indicate that perforation is threatened, and immediate operation is impracticable, opium may be given. In every case it is important to inspect the stools so that it may be known when the foreign body has passed.

If the foreign body is of such size that it cannot pass through the pylorus and intestine, or if it is of such shape that such a passage is likely to be dangerous, the stomach should be opened and the foreign body removed. This is true of large pins and needles with two points, and such objects as awls, knife-blades, etc. Operation is also indicated for the removal of balls of shellac, hair, and the like, especially since in these cases the diagnosis cannot always be made with certainty and a tumor may exist. The risk of a properly performed gastrotomy is extremely small. It should be carried out according to the principles given on page 414. If the foreign body has been for some time in the stomach, operation may be needed on account of ulcer, perigastritis, or perforation into the abdominal cavity or a neighboring organ or through the abdominal wall.

FOREIGN BODIES IN THE INTESTINE.

Foreign bodies in the intestine come for the most part from the stomach. Sometimes a biliary calculus enters the intestine through the natural channels or by rupture of the gall-bladder, while in very rare cases a calculus may pass into the intestine from the kidney or urinary bladder. Foreign bodies may enter the intestine directly from without. The passage of foreign bodies into the intestine from the abdominal cavity has been spoken of on page 214. Such objects set up a local peritonitis and cause perforation of the intestinal wall. The perforation may afterward heal and even the adhesions be resorbed. Neugebauer found that ten of twenty-eight pieces of gauze left accidentally in the abdominal cavity passed per anum, while one of four drainage-tubes and three of seventeen artery-forceps passed per anum. In twenty-nine other cases a sponge was left in the peritoneal cavity, and in no instance did it enter the intestine and pass per anum.

Objects which are introduced into the rectum may work their way upward, but never above the ileocæcal valve.

Foreign bodies may be formed within the intestine. They are of three sorts. An intestinal calculus or enterolith is always of small size. It is made up of calcium phosphate or carbonate and magnesia, and often contains as a nucleus the stone or seed of fruit. A fecal

calculus, or coprolith, is made up of compressed masses of feces. Such a calculus may reach an enormous size and be very hard. A fecal tumor is made up of fecal masses which still preserve their outline. These three forms of foreign bodies are never found in the small intestine except in case of partial fecal obstruction.

The fibres of plants, the seeds of fruit, or pin-worms, may be matted together to form a ball which will interfere with the fecal stream; but as a usual thing any foreign body which passes the pylorus will give no trouble farther down because the diameter of the pylorus is much less than that of the intestinal canal. However, the body may pass with difficulty certain sharp flexures of the intestine, such as the duodenal flexure, or, in rare cases, the flexures of the colon. The ileocæcal valve may obstruct the passage of the foreign body, but a far greater obstruction is afforded by the sphincter ani, so that many foreign bodies lie for a long time in the ampulla of the rectum. The small intestine, like the large intestine, is somewhat contracted in its lower end.

Some objects which from their size and shape ought to pass the intestine easily, produce such vigorous contraction of the muscles that they are held fast. This is especially true of a biliary calculus. According to Naunyn, a biliary calculus which measures more than 3 cm. (1.2 inches) rarely passes through the intestine without trouble. An exception exists in case the stone ruptures into the transverse colon. If a foreign body has some sharp hook or angle, it may become firmly fastened in the intestinal wall.

If any stenosis exists due to an ulcer or scar or new growth, a foreign body may be unable to pass it, and acting like a ball-valve it may set up symptoms of ileus. A foreign body may rest indefinitely in the cæcum or vermiform appendix, or in a congenital or acquired diverticulum of the intestine, and may do no damage, or at most produce an ulceration as long as the fecal current is unobstructed.

Symptoms and Diagnosis.—Foreign bodies which pass through the intestine usually give rise to no symptoms. Sometimes they may be felt through the abdominal wall. Any symptoms which may be produced are due generally to interruption of the fecal current or to ulceration which may go on to perforation. In these cases a distinct tumor can scarcely be made out. The interruption of the fecal current may be of any degree from the slightest up to complete ileus. Obstructive ileus and perforation may coexist.

It is easy to understand the occurrence of symptoms of this character if there is a history that the patient has swallowed a foreign body, or suffers from cholelithiasis, or has not yet recovered from a laparotomy. If the history does not throw any light upon the condition, the correct diagnosis may not even be suspected. From the symptoms the operator may decide that there is obstruction or that a peritonitis is present, but he may not suspect that the condition is due to a foreign body until operation or autopsy reveals it. In some cases the foreign body passes spontaneously even after it has produced

severe symptoms. Sharp objects, such as needles, splinters of bone or wood, may perforate the intestinal wall and give rise to an abscess in the abdominal wall without causing intestinal symptoms.

Fecal tumors develop in the large intestine when the fecal current is extremely sluggish. Whether such fecal masses should be considered foreign bodies is a disputed question. As they play an important part in differential diagnosis they are worth consideration. Such a fecal tumor may reach the size of the fist and can easily simulate a tumor of the intestine. The illusion is heightened by the fact that such a mass of feces may remain for weeks or months constantly in the same situation unaffected by an occasional laxative or enema. These fecal tumors yield, however, to a thorough laxative treatment. A characteristic symptom of fecal tumor is the fact that it may be indented by pressure with the fingers. Gersuny calls attention to the further fact that firm pressure with the finger will cause the mucous membrane of the intestine to stick to the fecal mass, but it draws away again when the pressure is removed. In doing so it gives rise to a peculiar crepitus which may be felt.

A fecal tumor may produce all the symptoms of intestinal obstruction, but it is seldom that no space is left between such a tumor and the intestinal wall. Formerly it was held that the ulceration due to a fecal tumor might continue until the wall of the intestine was perforated, but this view is not sustained by a more careful study of recent cases.

Treatment.—The treatment for a foreign body in the intestine is in general the same as that for a foreign body in the stomach. (See page 279.) Since relatively large and even pointed objects may pass through the intestine successfully, treatment should be at first an expectant one. If the character of the foreign body is such that its safe passage through the intestine is highly improbable, operation should be performed for its removal; otherwise operation should be delayed until the object catches somewhere and sets up symptoms of ileus or ulceration. In any event the patient should be kept under observation until the foreign body has passed the anus or has been removed.

If operation is performed, it is usually simple enterotomy with suture. If the foreign body has badly damaged the intestinal wall, a resection may be necessary. If the foreign body is wedged fast in the large intestine, it will be desirable under certain circumstances to establish a temporary artificial anus. This should never be done in the case of the small intestine unless one is absolutely sure that he is making the artificial opening near the cæcum. For further details of treatment see the chapters on Ileus and Peritonitis.

GASTRIC FISTULA.

A fistula of the stomach not the result of operation is rarely seen. Kronheimer in a recent article refers to 70 such cases, the fistula in most of them being due to gunshot- or stab-wounds of the stomach or

to some other traumatism. The fistula may follow either a puncturing or a subcutaneous injury. A puncturing wound may perforate the stomach or perforation may develop later as a result of circumscribed peritonitis. As the gastric perforation in most of these cases leads to perforative peritonitis and death, the rarity of a gastric fistula of this sort is easily explained. In 17 of the 70 cases above mentioned, the gastric fistula was due to a simple ulcer, and in about the same number to a carcinomatous ulcer. The gastric fistula may be the result of an accident after operation; for example, it may be due to giving way of imperfect suture of the stomach. The intentional formation of a fistula will be described on page 416.

Most gastric fistulas are situated in the anterior wall of the stomach below the border of the ribs. This portion of the stomach is most exposed to accidents, and it is in this situation that a perforating ulcer is most likely to produce a fistula. In perforation due to an ulcer in other portions of the stomach the site of perforation is separated from the anterior abdominal wall by the neighboring organs. Instances occur, however, in which perforation has taken place into the pleura and later through the thoracic wall.

A fistula may be of any size, even so fine that it will admit no probe. It may lead directly into the stomach or indirectly after it enters a hollow space. In the first case the fistula is usually lined with mucous membrane.

Diagnosis.—The diagnosis of a gastric fistula depends upon the discharge through it of gastric contents or of test-substances which have been swallowed. A fistula of the duodenum above the papilla of Vater is not to be differentiated from that of the stomach, except that test-substances which are swallowed usually appear a little later.

If the fistula is very small, it may be difficult to demonstrate its true character because the acid fluid from the stomach when mixed with the secretion of the fistula itself may be neutralized or even made alkaline; while the use of a probe under such circumstances will probably yield no positive information. The chief importance of a gastric fistula is the loss to the patient of nutriment and gastric juice. The larger the proportion of gastric contents which escapes through the fistula, the more serious the loss to the patient, so that if the fistula is a large one death from starvation may follow. In Wölfler's 58 collected cases, 11 patients died from the fistula, 27 suffered with it at the time of the report; 14 recovered spontaneously and 4 as a result of operation. The celebrated Canadian, Alexis St. Martin, lived thirty-five years with a gastric fistula.

An annoying result of the gastric fistula is the irritating and distressing action of the gastric juice upon the tissues around the fistula. As a result of this the skin is affected by a painful eczema and ulceration.

Treatment.—The treatment of gastric fistula varies according to its size. A small fistula may heal spontaneously or may be stimulated to do so by caustics or the thermocautery. This simple cure is easily

obtained when the fistula is not lined with mucous membrane. For example, a fistula which is established according to Witzel's method of gastrostomy heals in a short time after the drainage-tube is removed. Larger fistulas require for their certain closure a carefully performed gastrorrhaphy. The various plastic operations which were previously in vogue for the closure of a gastric fistula do not merit description since they were all founded upon the fear of opening the abdominal cavity. They often failed of result.

If a gastric fistula cannot be closed by a simple suture, the abdominal cavity should be opened, the stomach freed, the perforated portion excised if necessary, and the opening in the wall of the stomach closed by a double row of sutures. (See page 398.) The first operation of this sort was performed by Billroth in 1877.

If the gastric fistula is due to carcinoma, a radical operation will usually be impossible. Under such circumstances a jejunostomy may be desirable.

A fistula may exist between the stomach and some other hollow abdominal organ, the commonest being between the stomach and transverse colon. This is usually due to ulceration of the stomach, rarely to that of the colon. This condition may be suspected if food is found in the stools in a state of digestion that is normal in the stomach. The presence of gastric juice in the stools and the discharge per anum within a limited time of test-substances which have been swallowed are significant signs. In many cases it is possible to distend the stomach with gas or fluid injected through the rectum. Sometimes fecal matter from the large intestine will enter the stomach and may be vomited. The vomitus will not resemble the fecal vomitus seen in ileus, but will contain smaller or larger particles of well-formed feces. Such fecal vomiting may be simulated by insane or hysterical patients, who have been known to put feces in their mouths for this purpose.

If a free communication exists between the stomach and colon, there is imminent risk of death by starvation. If a fistula exists between the stomach and small intestine, this risk is less serious. If a fistula of this character produces serious symptoms, laparotomy should be performed, the affected organs separated, the diseased tissue excised if necessary, and both perforations closed by suture.

EXTERNAL INTESTINAL FISTULA.

An external intestinal fistula or a fecal fistula, as it is usually called, is developed in several ways :

1. A penetrating wound may lead to intestinal fistula just as it may lead to gastric fistula. The wounded intestine may adhere to the wound in the abdominal wall and the discharge take place directly, or the discharge of feces may set up a local peritonitis and a fecal abscess which subsequently bursts outward. Subcutaneous injury may produce a fistula in this manner. An intestinal fistula may be connected with some portion of the intestine, duodenum, or colon which is not covered

with peritoneum. Such a fistula may be due to traumatism or to an ulcer.

2. An intestinal fistula may be functionally established for the introduction of nourishment or the discharge of feces (page 458); or it may accidentally follow an operation on account of an imperfect suture or tamponade after suture, etc.

3. An incarcerated hernia may become gangrenous and perforate externally and so produce an intestinal fistula. If the patient does not die as a result of peritonitis, the hernia may be cured in this manner. An intestinal fistula may be produced at the umbilicus by the division of an abnormal umbilical cord. (See page 142.)

4. Intestinal fistula may follow ulceration of the intestine secondary to tuberculosis, carcinoma, actinomycosis, or appendicitis.

5. Tuberculosis or other disease of the peritoneum or abdominal wall may produce perforation of the intestine and ultimately an intestinal fistula. This is true of tuberculosis of the pelvis, which may produce a cold abscess that ruptures into the intestine.

While an intestinal fistula may connect with any portion of the intestine, it is most likely to occur in certain situations, especially in the inguinal and ileocæcal regions. In the latter region are situated many inflammatory processes (appendicitis, tuberculosis, and actinomycosis) as well as many tumors. The umbilicus is also a relatively common seat of intestinal fistula.

The opening into the intestine may be of various sizes. These fistulas are divided into direct and indirect. In the latter case, as in indirect fistula of the stomach, there exists between the intestine and the abdominal wall a larger or smaller hollow space. The fistula may be lined with mucous membrane or with granulations. In the first case the fistula is pretty sure to be short.

For the distinction between a simple fecal fistula and an artificial anus see page 457. This distinction is well illustrated in Fig. 73.

FIG. 73.

Diagrams of an intestinal fistula and of an artificial anus: *a*, efferent, and *b*, afferent bowel.

Properly speaking, an artificial anus is such a fistula as discharges all the contents of the intestine. There are all degrees between this and a fistula which discharges only a few drops of fluid. The quantity of fecal matter discharged is dependent partly upon the size of the fistula, but still more upon the freedom with which the afferent

and efferent portions of the bowel connect with one another and the closed or open condition of the efferent portion.

When a loop of intestine is attached to the abdominal wall, it has a constant tendency to draw away. This is due to the peristaltic action and to the firm hold of the mesentery. As a result of this, adherent intestine may become again entirely free. Furthermore, when there is a cylindrical fistula the constant traction upon it draws it out into a funnel, the point of which is directed outward, until finally it may become closed by granulations, and being covered internally by mucous membrane, a perfect cure results. If the whole fistula is lined with mucous membrane so that it cannot unite, the tendency of the intestine to draw away from the abdominal wall brings the afferent and efferent portions of the bowel into more and more of an acute angle until finally these two portions lie parallel with a well-marked spur between their lumina. This spur corresponds to the mesenteric attachment of the intestine. In the case of strangulated hernia with sloughing of the incarcerated bowel the spur exists from the first.

There are other influences which affect the condition of a fistula. Peristaltic action in the afferent portion tends to bring the mucous membrane out of the fistula if the lumen of the bowel is directed obliquely or perpendicularly to the surface, while peristaltic action in the efferent portion has the opposite effect. Intra-abdominal pressure tends to produce a hernia at the site of the fistula. As a result of these two forces, if the fistula is a large one, the mucous membrane will not only reach the level of the skin, but will also become everted much beyond it, and indeed there may be prolapse of the whole thickness of the afferent intestine. The prolapsed intestine may become strangulated. When the spur reaches the level of the skin, no fecal contents will pass over it into the afferent portion of the bowel.

The effect of a fecal fistula upon the general health of an individual depends upon the amount of nourishment which is lost through it. This is due, first, to the situation of the fistula; and second, to the amount of fecal discharge. If the fistula is in the lowest portion of the ileum or in the colon, the loss to the individual in the matter of nourishment is trifling even though the whole fecal current passes out through the fistula. It is difficult to determine the exact situation of a fecal fistula of the small intestine, and such a patient should be regularly weighed. It will soon be evident whether or not he is losing ground on account of the fecal discharge. Every fecal fistula is a great annoyance to the patient aside from the possible loss of nourishment which it produces. Suitable apparatus, such as that described on page 463, lessens this annoyance to a minimum in the case of a fistula which discharges solid fecal masses. If the discharge is a fluid one, such as always comes from a fistula connected with the small intestine, and from one connected with the large intestine when diarrhœa is present, the apparatus will rarely control the discharge. In such cases the most careful cleansing will hardly be able to prevent eczema of the skin around the mouth of the fistula. This eczema is often very pain-

ful, and renders the use of controlling apparatus absolutely impossible. The skin in such a condition is ill adapted to operation, since it cannot be thoroughly cleansed and it does not readily heal; hence every attempt should be made by frequent dressings and the use of salve upon the surrounding skin to overcome the eczema before performing an operation. In some cases it is better to keep the patient in a permanent water-bath. Such treatment may succeed in curing the most obstinate eczema, although several weeks may be required for this. Orthoform, cocaine, and similar remedies may be mixed with the dusting-powder or salve in order to relieve the pain.

Diagnosis.—The diagnosis of intestinal fistula is simple if the discharge contains much fecal matter. Its character will then be made manifest by the presence of biliary pigments, which are yellow or greenish in the upper portion of the small intestine and dark brown in the large intestine. More or less gas will pass through the fistula in almost all cases. If a fistula discharges only a few drops of mucus, diagnosis is more difficult. A test of the digestive power of so small a quantity of fluid is unsatisfactory, and such fluid might be derived from some isolated portion of intestine, as may be the case with congenital umbilical fistula. The odor of the discharge may mislead, since the contents of an abscess situated close to the intestine often have a fecal odor due to development in it of *Bacterium coli*. Furthermore, the contents of the upper portion of the small intestine possess very little odor. The microscopical examination of a discharge may clear up the diagnosis by showing the presence in it of striated muscle-fibres, starch-granules, vegetable fibres, or some substance, such as charcoal or lycopodium, which has been swallowed as a test. In order to facilitate the collection of a discharge a fistula may be temporarily plugged.

It is sometimes of great importance to determine whether a fistula is situated high up in the small intestine. If so, it may be unsafe to delay operation until an eczema has healed. Some idea of the situation of a fistula may be obtained by the color of the bile, by the degree of digestion shown in the discharge, and by the length of time which elapses between the ingestion of a test-substance and its appearance at the mouth of the fistula; but such facts are less significant than a steady gain or loss in weight.

A fistula of the large intestine may sometimes be differentiated from one of the small intestine by injecting water into the rectum, since the fluid will rarely pass the ileocæcal valve. The length of time which elapses before the water flows out of the fistula and the quantity of water which may be introduced without its discharge through the fistula, are other points which may assist in diagnosis. Sometimes the mucous membrane which appears at the mouth of a fistula is sufficiently characteristic for a diagnosis. The mucous membrane of the small intestine looks like velvet on account of its numerous villi, while that of the large intestine is smooth and shiny. If the fistula has existed a long time, these characteristics may be altered.

In fistula so large that two openings in the bowel are visible or

palpable, it may be important to determine which is the afferent and which the efferent portion. The discharge of fecal matter will usually determine this point. Furthermore, the afferent bowel is larger and shows a greater tendency to prolapse, while the efferent bowel is much contracted, and if the condition has existed a long time even atrophic. A spur is a prominent feature of a large fistula, but it cannot be seen through a small one, although its presence may be shown by introducing two probes.

Treatment.—The discomfort of every intestinal fistula is so great that it should always be closed if this can be done with safety to the individual. In some cases success follows a simple operation, while in others the conditions are so complicated that much time and patience are required before closure can be effected.

For practical purposes intestinal fistulas may be classed as simple and complicated. A simple fistula is one produced by some affection or traumatism which has been entirely recovered from; for example, a fistula due to strangulated hernia or to some operation. A complicated intestinal fistula is due to some disease which still exists; for example, appendicitis, tuberculosis, actinomycosis, carcinoma. Under such circumstances treatment of the disease itself overshadows that of the fistula, and the cure of the fistula by one of the various methods previously described will usually depend upon the ability of the surgeon to remove the diseased portions. The treatment of such diseases is considered elsewhere, while the operative treatment of a simple intestinal fistula is described on page 463.

INTERNAL INTESTINAL FISTULA.

A fistula may connect the intestine with some other hollow organ. This organ may form a part of the alimentary canal (gastro-intestinal fistula); or it may be associated with the alimentary canal (fistula between the gall-bladder and the intestine); or it may have no normal connection with the alimentary canal (kidney, pelvis of the kidney, ureter, bladder, Fallopian tube, uterus, vagina). Finally the fistula may lead into the pleural cavity. Such a fistula may be due to some one of the various causes mentioned in the preceding pages or it may result from a calculus within the organ in question (cholelithiasis, nephrolithiasis, etc.).

An internal fistula usually exists between adjacent organs; for example, between two coils of intestine, or between the kidney and the adjacent colon or duodenum, between the small intestine and the female pelvic organs, etc.

A fistula between different portions of the alimentary canal, or one between the biliary and alimentary tracts, causes few or slight symptoms unless a considerable portion of intestine is eliminated. In that case symptoms of starvation may arise.

Gastro-intestinal fistulas have been spoken of on page 283.

A fistula between the biliary passages and the intestine is not so

very rare. In the normal condition of the biliary ducts a stone larger than a cherry cannot pass through them into the duodenum. A larger stone can only enter the intestine by rupture of the wall of the duct or of the wall of the gall-bladder, and if commencing necrosis causes the affected wall to adhere to the intestine the rupture will take place without discharge of fluid into the peritoneal cavity. Sometimes this occurs without special symptoms, and sometimes there are symptoms which cannot be distingnished from those of cholangitis or of local peritonitis. When the fistula has once been established, it gives rise to no further symptoms, and the abnormal opening into the intestine does not seem to injure the biliary passages, although, as shown by recent examination by Radziewski, intestinal bacteria penetrate to the finest radicles of the biliary tract. Probably the continuous flow of bile protects the liver from serious infection. Such a fistula, as far as known, has never given rise to surgical operation for its relief. If the bile passes directly into the large intestine, the absorption of fat from the food may be much reduced.

Fistulas between the rectum and some portion of the genital tract are not uncommon. These are discussed in another section of this book. Pregnancy is the commonest cause of genital fistula, which opens above the rectum. Many of these fistulas result from operations performed during labor and others from inflammation which attacks some adjacent portion of intestine and sets up a fistula. Others come from operations performed for the removal of tumors, etc., and still others from disease of a pelvic organ or intestine, for example, tuberculosis.

Narath, who searched the literature on this subject up to 1896, found records of 14 cases of fistula between the intestine and uterus. In 10 of these the fistula opened into the small intestine, once into the small intestine and cæcum and three times into the sigmoid colon. He found 25 cases of fistula between the vagina and intestine, in 23 of which the small intestine was involved. The portion of the small intestine involved in these cases was almost invariably the ileum.

Diagnosis.—The presence of a fistula between the intestine and genital organs is shown by the discharge of fecal matter from the latter. This of itself is disagreeable to the patient, and in addition there may be a serious loss of nutritive material if the fistula is high up. The diagnosis is usually not difficult. Palpation and inspection will show whether the fistula connects with the vagina, and if not, it probably opens into the uterus, as an opening into a Fallopian tube is extremely rare.

A fistula between the kidney and the duodenum may lead to death from starvation. A fistula communicating with the colon is not so serious Both of these conditions are extremely rare.

Chavannaz collected reports of 95 fistulas between the bladder and intestine. The portion of intestine involved was, 43 times the rectum, 14 times the sigmoid colon, 8 times some other portion of the colon, 8 times the small intestine, 4 times both the colon and small intestine, and once the appendix. In 18 cases it was uncertain what portion

of the intestine was involved. The cause of the trouble was, 5 times tuberculosis, 9 times some other inflammatory process, 4 times carcinoma, and twice trauma.

The establishment of a fistula between the sigmoid flexure and the bladder in case of carcinoma of the former organ is by no means rare. The fistula may reveal itself by the sudden development of cystitis or by the passage of gas with the urine. In some instances the passage of gas with the urine is noticed before the carcinoma of the intestine has been suspected. When the disease has gone thus far, radical operation is, of course, impossible.

The result of a fistula between the intestine and bladder may be the discharge of urine into the intestine or feces into the bladder. Sometimes there is a flow in both directions. The presence of more or less urine in the intestine does not excite serious symptoms. If it is discharged into the lower intestine, it passes out of the anus, and if it is discharged into the upper intestine it is partly resorbed. If it is discharged into the duodenum or stomach, it may excite vomiting. If renal calculi exist, they may pass with the urine through the fistula. Morris mentions a case in which they were discharged from the mouth, the nose, and urethra.

The escape of feces into the urinary passages is a much more serious matter. Inflammation is set up in the bladder and the infection soon spreads to the ureters and then to the kidneys, for the description of which the reader is referred to the sections devoted to these organs.

Diagnosis.—The diagnosis of a fistula between the intestine and bladder is often easily made either macroscopically or microscopically. If the fistula discharges feces sporadically, none may be in the urine at the time of examination, and the diagnosis may therefore be in doubt. The facts that the urine has a fecal odor and that gas is passed from the bladder are not alone sufficient for the diagnosis of fecal fistula since the urine may possess these characteristics although an actual communication with the intestine does not exist. In doubtful cases test-substances, such as lycopodium or raw starch, may be swallowed and sought for in the urine. If the current in the fistula is from the bladder to the intestine, the patient may be given methyl-blue or some other substance which is eliminated through the kidneys, in order to see if it will appear in the feces.

Treatment.—The treatment of an internal fistula is similar to that of an external one. If the patient suffers from incontinence or is threatened with starvation, an attempt should be made to close the fistula. Small fistulas usually close spontaneously. If they open into the vagina or some other accessible organ, they may be touched with caustic or a plastic operation may be performed. The treatment of fistula between the rectum and bladder or vagina is discussed in connection with the diseases of the rectum. Treatment in all other cases should be by laparotomy. The affected organs should be separated one from the other and each closed by suture. Sometimes an additional operation

must be performed, such as circular resection of the intestine, intestinal anastomosis, nephrotomy, nephrectomy, etc. The surgeon must always be sure that the feces and urine can pass through the natural channels or else he must devise some new way for their escape.

The separation of the intestine from the other hollow organs may present such difficulties that it may be better to close either one or both ends of the adherent portion of the intestine, thus separating it at one or both ends from the rest of the intestine. Operation for internal intestinal fistula should only be undertaken when the cause of the fistula is capable of being overcome. Thus, if a fistula is due to an inoperable carcinoma or tuberculosis, it had better be left alone.

STENOSIS OF THE PYLORUS.

Stenosis of the pylorus gives rise to a more or less pronounced group of symptoms which are not wholly separable from the disease which produces the stenosis. This topic is properly considered in a surgical text-book since internal remedies are rarely sufficient to effect a permanent cure except perhaps in cases of pyloric spasm, a condition which is not thoroughly understood. Surgical treatment by removing or circumventing pyloric stenosis has won many striking successes; therefore a mechanical stenosis of the pylorus may well be considered as a surgical disease.

In speaking of stenosis of the pylorus reference is made to any narrowing whether it be situated exactly at the pylorus or below it, but not below the papilla of Vater. The chief causes of such narrowing are scars the result of caustics or ulcers, fresh ulcers, and new growths, usually of the nature of carcinoma. Occasionally a foreign body becomes wedged in the pylorus, or the pylorus is partially obstructed by external compression or external adhesions. There are also congenital anomalies and instances of muscular spasm. From the nature of the case pyloric stenosis is in most instances a slowly progressing affection, with periods of comparative quiet and possibly of improvement.

Symptoms.—Dyspepsia is one of the chief symptoms of stenosis of the pylorus, and is marked by anorexia, nausea, coated tongue, eructations, bad taste in the mouth, etc. These symptoms are partly due to the overfulness of the stomach or its delay in emptying itself, and are partly due to a catarrh of the mucous membrane which sooner or later develops. The catarrh may be the direct result of obstruction or it may be due to an ulcer or cancer which causes the obstruction. Pyloric stenosis is not of itself painful, but the patient usually experiences a feeling of weight in the epigastrium and more or less pain when external pressure is made. This pain on pressure is diffuse and not circumscribed, as is almost always the pain due to ulcer. If the stenosis is an accompaniment of recent ulceration, there may be a point in the back painful to pressure. Otherwise this sign is wanting. Sometimes the active peristaltic motions of the stomach are painful. Vomiting is

always present if the stenosis is well marked, and it is often produced by a moderate degree of stenosis. It may be due to an unnatural distention of the stomach or to irritability of the mucous membrane as a result of the catarrh, etc. In extreme cases vomiting continues even though the stomach is empty. A patient whose stomach is overloaded may vomit early in the morning food eaten the preceding day, or, indeed, the food vomited may have been eaten several days before. This one symptom alone is not sufficient to establish a diagnosis of overdistended stomach since particles of food may remain hidden for some days in the pouches of the ulcerating tumor and later be expelled by vomiting.

The motor function of the stomach is disturbed. The retention of food may be slight, or it may be complete, so that nothing passes the pylorus. Such absolute retention is rarely seen since the trouble develops gradually, and before retention becomes absolute the patient usually dies. Therefore complete pyloric obstruction is an acute trouble. (See page 294.)

For convenience motor insufficiency is divided into degrees. In the first grade digestion is delayed, but early in the morning the stomach is found empty. In the second grade it still contains food ten or twelve hours after the meal; that is to say, it never completely empties itself. This disturbance of motor function depends partly upon the size of the pylorus and partly upon the power of the muscles of the stomach. These patients suffer greatly on account of the atrophy which affects the gastric wall as a result of catarrh. The loss of muscular power is more marked in malignant than in benign stenosis. There is often a disproportion between the degree of anatomical stenosis and the loss of muscular power. The overloading of the stomach often results in dilatation of the stomach or ectasia, as it has sometimes been called.

The terms dilatation of the stomach and motor insufficiency of the stomach are by no means synonymous since there may be great loss of muscular power even in a small stomach. An example of this is a diffuse cancerous infiltration without enlargement of the stomach. In other cases a stomach which exhibits motor insufficiency may be much shrunken. There are also instances of dilated stomach in which there is no muscular insufficiency. Such a condition is common in diabetes.

A dilated stomach usually sinks toward the lower abdomen, a condition known as gastrectasia. If the gastrectasia is of high degree, the abdomen presents a characteristic appearance. The mesogastrium or hypogastrium contains the much distended organ, while the epigastrium sinks in above the transversely placed lesser curvature. This condition can often be observed without artificial distention of the stomach, although such artificial distention makes the appearance more striking. In some cases a sort of vicious circle is found. The distended and sunken greater curvature of the stomach dragging upon an adherent pylorus produces a kink which increases the degree of stenosis, and this leads again to increased distention and sinking of the stomach. Splashing sounds often accompany pyloric stenosis and may

be the source of great annoyance to the patient. These signs have little weight in diagnosis unless they are heard at a time when the stomach should normally be empty. Then they are indicative of motor insufficiency.

Like other hollow muscular organs, the stomach attempts to overcome the stenosis by increased muscular effort. This increased peristalsis may be of two kinds. The usual form is an increased normal peristalsis, the waves of which proceed from left to right, and which are produced spontaneously, or may be called forth by massage or tapping upon the stomach. The thinner the abdominal wall the more readily such increased peristaltic action can be observed. As normal peristaltic motion of the stomach can scarcely be detected even in very thin persons, a well-marked peristaltic wave may always be regarded as pathological. The other form of increased peristaltic action is rarely seen. It is a sort of stiffening of the gastric wall which comes on spontaneously or as a result of irritation, and may involve the whole stomach or only part of it. Such a condition manifests itself by the convexity communicated to the abdominal wall, while the tension of the stomach can easily be detected by palpation. In a few minutes this rigidity subsides or passes into peristaltic waves. Sometimes the two forms of peristaltic action coexist or one follows the other. This gastric rigidity is often painful while the increased peristaltic action in the form of waves rarely causes pain.

The increased capacity of the muscular wall results in hypertrophy within certain limits. Sooner or later the hypertrophy gives way to dilatation.

Increased peristalsis is almost invariably a sign of pyloric obstruction, although in rare instances it may have a purely nervous origin. Still, the absence of increased peristalsis is no proof that stenosis does not exist. Such an increased peristalsis may already have passed into one of atony or the atonic condition may have developed directly as a result of stenosis without an intermediate hypertrophic stage.

Stenosis of the pylorus is not in itself palpable, although the condition which leads to it may be. Stenosis may be accompanied with increased, normal, or decreased acidity, or there may be an absence of free hydrochloric acid. This depends not upon the stenosis, but upon the condition of the mucous membrane of the stomach. If the degree of motor insufficiency is slight, the stomach will often produce great quantities of acid secretion. If hydrochloric acid is absent, lactic acid develops sooner or later even though the patient has no carcinoma. If there is well-marked atrophy of the mucous membrane, a state of achylia gastrica may be brought about. Mechanical obstruction leads to an increase in bacteria. As long as the gastric contents contain hydrochloric acid the ferments found are chiefly yeast and sarcinæ. When hydrochloric acid is absent, lactic acid ferments are also present.

The effects of pyloric stenosis upon the general system are due to the decreased absorption of nourishment. Food which does not pass the pylorus but remains in the stomach and undergoes degenerative

changes, is of little value to the body since the stomach has scarcely any power of resorption. Furthermore the decay of the gastric contents produces poisonous substances which exert an unfavorable influence upon the body. Thus the patient loses weight, especially on account of the reduced absorption of fluid, while the secretion of the stomach is increased. This anhydræmia, as the decrease of fluid in the body has been called, is shown by dryness of the skin and mucous membranes, diminution in the quantity of urine, and the high specific gravity of the same. The quantity may be less than 300 c.c. in twenty-four hours. The patient suffers from thirst which the overfull stomach cannot relieve. In spite of the bad appearance presented by the patient his blood may contain a normal or even an increased percentage of hæmoglobin, a fact which is explained by the decrease in the fluids of the body. This is even the case when the stenosis is due to carcinoma. The stools are scanty and hard and the patient complains of obstinate constipation.

Diagnosis.—The various symptoms described above suffice in most cases to establish a diagnosis of pyloric stenosis. Stagnation of the gastric contents is shown by passing a stomach-tube before food has been taken in the morning and by examination after breakfast and after a test-meal. The degree of stagnation can always be known. The methods of examination are spoken of in Chapter XII. The degree of anatomical stenosis is not of practical importance. Prognosis and treatment rest rather upon the functional disturbances of the digestion as shown not only by the condition of the stomach, but also by the condition of the whole body; therefore such symptoms as emaciation, anhydræmia, and ischuria are fully as important as the more strictly local symptoms.

There are two conditions which must be differentiated from pyloric stenosis. One is the so-called idiopathic or atonic insufficiency, and the other is a neurotic pyloric spasm. A differential diagnosis between idiopathic insufficiency and pyloric stenosis cannot be made with certainty, but this is of no great practical importance since the idiopathic insufficiency occurs very seldom, and when it does occur it will usually be treated surgically by the creation of a more favorable exit for the gastric contents, that is to say, by a gastro-enterostomy.

Pyloric spasm will be accompanied by other well-marked symptoms. This condition is also one of extreme rarity, and if it leads to the same disturbances as a true stenosis of the pylorus, it requires the same sort of treatment, namely, that the abnormally contracted pyloric muscle should be overcome by pyloroplasty or gastro-enterostomy.

Prognosis and Treatment.—If the pyloric stenosis is of slight degree, it may produce a number of unpleasant symptoms, but does not harm the general organism. If it is of severe degree, the injuries which it exerts upon the general organism are marked and tend to increase as a rule. Internal treatment, gastric lavage, forced feeding, rectal feeding, electricity, and massage all fail to cure well-developed pyloric stenosis; consequently surgical treatment is absolutely indicated if

there is motor insufficiency of the stomach and the general health is affected.

If the stenosis is of slight degree, treatment will depend a good deal on the cause of the stenosis. If carcinoma is suspected, operation should be performed at once, whereas if the stenosis is due to a recent ulcer medicinal treatment should be employed. When this fails and the condition of the patient is growing worse, operation is indicated.

The aim of surgical treatment should be to overcome the cause of the trouble when this is possible. Stenosis due to carcinoma and to benign ulcer is spoken of on pages 320 and 376. If the stenosis is due to external compression, for example, that caused by an adherent gall-bladder, or if it is due to kinking and adhesions, the mechanical cause should be removed. If this is not possible, the harmful effects of the stenosis may be overcome by gastrojejunostomy (page 428), or, in rare cases, by gastroduodenostomy (page 427). If the stenosis is a purely cicatricial one, or is due to spasm of the pylorus, either a pyloroplasty (page 423) or gastro-enterostomy may be performed. Pyloroplasty is preferable when the conditions are such that it can be easily and safely performed. A successful plyoroplasty restores the physiological conditions. Gastro-enterostomy produces a new outlet to the stomach which may act perfectly or it may produce new difficulties. Cases of ulcer of the jejunum following gastro-enterostomy show that this organ sometimes suffers from the direct flow into it of the acid gastric contents. In hyperacidity of the stomach this is a real objection to gastro-enterostomy if pyloroplasty is technically feasible.

Hour-glass Stomach.—Stenosis of the body of the stomach is a condition which in rare cases is congenital. Its usual cause is an extensive ulcer or the scar which results therefrom. The symptoms of hour-glass stomach are stagnation of the food together with the various results which may follow delayed digestion, and which have been spoken of in detail in this chapter. The farther the stenosis lies from the pylorus, the more striking will be the difference, shown by physical examination, between this condition and that of pyloric stenosis. But in many cases the diagnosis of hour-glass stomach, if made at all, will be more or less a probable one. Indeed, the differential diagnosis between this condition and that of stenosis of the pylorus has little practical importance since in either case operation is indicated and the operator will have to be guided by what he finds after the abdomen is opened. Hour-glass stomach may be treated by gastro-anastomosis or gastroplasty or gastro-enterostomy, or a combination of the last-named two operations. (See page 427.)

Acute Pyloric Obstruction.—This condition as compared with chronic stenosis is extremely rare. It may be produced by a foreign body or by a kink, but the obstruction under such circumstances is likely to be incomplete. Sometimes operation upon the lower biliary passages is followed by acute obstruction of the duodenum due to a deeply seated tampon. The results of such obstruction are dilatation

of the stomach with continuous vomiting, symptoms which rapidly subside if the tampon is removed.

By far the commonest cause of acute pyloric obstruction is acute gastric dilatation. If the stomach is abnormally low in the abdomen and its dilatation reaches a certain degree, a kink is produced at the pylorus which may absolutely prevent the escape of gastric contents into the intestine. Such a kink may occur at a point where the movable superior portion of the duodenum joins the fixed descending portion, or it may occur at a point where the superior mesenteric vessels cross the inferior portion of the duodenum. If the dilated stomach pushes the small intestine firmly downward, the mesentery may so press upon the duodenum as to obstruct its lumen.

The causes of acute gastric dilatation which have been noted are overfilling of the stomach, narcosis, especially in operations upon the biliary passages, lesions of the spinal cord, and external compression by a band, plaster-of-Paris jacket, etc.

If the pylorus is obstructed, the stomach may become enormously dilated in a short time. It may extend to the symphysis. The muscles of the stomach, already weakened and overdistended, are unable to empty the organ. It has been suggested that there is a valvular obstruction of the cardia, but this seems doubtful since the most extreme cases are accompanied by repeated vomiting. If the obstruction is at the point where the mesenteric vessels cross the duodenum, the vomitus will contain bile. Unless the obstruction is speedily relieved the patient will die.

Treatment.—The treatment of acute gastric dilatation consists in the emptying of the stomach by means of a tube, which alone will suffice in many cases to relieve the obstruction. Elevation of the pelvis or a knee-chest position of the patient is often of service by bringing the small intestine up out of the pelvis. In view of the extreme paralysis of the gastric muscles it is doubtful whether gastro-enterostomy is indicated.

Wiesinger observed a case of volvulus of the stomach with obstruction of both the cardiac and pyloric orifices, which he relieved by operation.

CHRONIC INTESTINAL STENOSIS.

Certain symptoms follow gradual obstruction of the intestine whatever may be its cause. These symptoms are often so prominent that they mask other symptoms due to a particular lesion. These symptoms of chronic intestinal stenosis are of the greatest importance since they form a clear indication for operation irrespective of the nature of the lesion. When the abdomen has been opened, it will usually be possible to recognize the cause of stenosis, and accordingly to perform resection of the intestine, entero-anastomosis, elimination of a portion of intestine, or to establish a fecal fistula, etc.

A moderate contraction of the intestinal lumen may give rise to no

symptoms whatever, and will not therefore be recognized unless it is complicated by kinking or adhesions, etc. Under such circumstances a moderate degree of stenosis may be suddenly changed to a complete obstruction which will produce the symptoms of acute ileus. For the sake of convenience the causes of chronic intestinal stenosis may be divided into those which act from within the intestine and those which act upon it by pressure from without. In the former class are cicatrices following ulcers, tumors, foreign bodies, and muscular spasms, and in the latter class tumors outside the intestine, abscesses, kinking, and adhesions. Just how soon the stenosis begins to obstruct the fecal stream depends partly upon the character of the feces, whether fluid or solid, and partly upon the power of the intestinal muscles. Thus in the small intestine the stenosis may reduce the lumen to the size of a lead pencil without producing symptoms. When the stenosis becomes so marked that the fecal stream is interfered with, the intestine above it gradually dilates and there follows hypertrophy of the muscular walls due to increased peristaltic action. This hypertrophy of the musculature shows itself very promptly, in some cases within a few days, and it may suffice to overcome the obstruction for a long time. This condition is exactly similar to eccentric hypertrophy of the heart. It has, of course, its limits, and if the stenosis is permanent or progressive, as is usually the case, the intestine above the stenosis will become enormously dilated and its wall although thickened will be partially paralyzed. As a result of circulatory disturbances ulcer may develop and may lead to perforation.

The length of intestine which is involved in hypertrophy and dilatation varies greatly, as does the degree of dilatation. The portion of intestine below the stenosis shrinks on account of the limited quantity of feces which passes through it. Thus either the small or the large intestine may appear no greater than the little finger. In rare cases the lower portion of the intestine is also dilated.

The symptoms due to intestinal stenosis vary according to the portion of intestine affected. They will be described under the three headings of stenosis of the duodenum, stenosis of the small intestine, and stenosis of the large intestine. Stenosis of the rectum is described in Volume V.

Stenosis of the duodenum produces symptoms which differ according as the stenosis is above or below the papilla of Vater. If it is above this papilla, the flow of bile and pancreatic juice is not interrupted, whereas if it is below the papilla, these fluids will flow, at least in part, into the stomach. If the stenosis is at the papilla, the flow of bile and pancreatic juice may be partially or wholly interfered with.

The symptoms of suprapapillary stenosis are almost identical with those of pyloric stenosis. The upper portion of the duodenum dilates, and this dilatation extends to the pylorus and later to the stomach. As the secretion of the portion of the duodenum above the papilla is not especially characteristic, the contents of the dilated stomach will

not differ from those of the stomach which is dilated as a result of pyloric stenosis. This is true whatever the cause of the stenosis.

In infrapapillary stenosis more or less of the bile and pancreatic juice will find their way into the stomach and will give to its contents well-marked characteristics. It is very significant of this form of stenosis, if when the stomach has been washed out and the water is returning clear it suddenly becomes tinged with bile, although no pressure has been made. If the stenosis is of marked degree, a diminution of the bile and pancreatic juice may be noted in the stools. If the stenosis is of mild degree, it is well-nigh impossible to distinguish it from suprapillary stenosis.

Papillary stenosis when well developed gives rise to characteristic symptoms. This is especially true of carcinomatous stenosis. There will be icterus of a chronic character, although the symptoms of obstruction in the liver and gall-bladder are slight or wanting. Bile may be diminished or wholly wanting in the stools. The obstruction to the flow of pancreatic juice may lead to glycosuria and the stools will show evidences of faulty pancreatic digestion. This condition must be differentiated from cholelithiasis, carcinoma of the gall-bladder, and carcinoma of the pancreas.

Stenosis of the upper portion of the jejunum produces essentially the same symptoms as infrapapillary duodenal stenosis. The farther down it is situated, the more prominent the intestinal symptoms become and the less prominent the gastric symptoms. The symptoms of chronic gastric retention will not be present unless there is a high degree of stenosis. Temporary retention of food in the stomach with vomiting may be due to the fact that chronic intestinal stenosis becomes temporarily a complete stenosis. Under such circumstances the contents of the intestine above the stenosis may pass into the stomach and be vomited. The stagnation in the intestine leads to abnormal bacterial development, and this gives to the vomited material a strong fecal odor. Intestinal stenosis may produce vomiting by reflex action even though there is no gastric retention. Thus vomiting may accompany attacks of colic. Material vomited from such a cause will come only from the stomach and duodenum. Stenosis of the small intestine gives rise to such dyspeptic symptoms as loss of appetite, eructations, bad taste in the mouth, coated tongue, etc. A patient with intestinal stenosis usually learns that hearty eating brings on an attack of colic, and therefore limits his diet as much as possible though his appetite is good.

The most important symptoms of intestinal stenosis are the visible dilatation and increased peristalsis of the portion of the intestine above the stenosis. When the stricture is situated very high up, the portion of intestine above it is too short to permit of marked dilatation, since the fluid easily regurgitates into the stomach. Such regurgitation is more and more difficult the farther the stenosis is removed from the stomach. Local meteorism is therefore produced. This may be diffuse or distinctly local. Sometimes the exact outline of the intestine may be made out, especially if the abdominal walls are thin or the recti

muscles are widely separated. The distinctness with which the intestinal coils may be seen or even felt depends not only upon the degree of dilatation, but also upon the contraction of the intestinal wall. This contraction may occur in waves corresponding to normal peristalsis. These waves begin at about the same point, and all end at a definite point, which is, of course, the point of stenosis. The contraction may also be of a tonic character. This tonic contraction takes place as follows: The larger or smaller portion of intestine whose outline was not previously visible becomes suddenly uniformly contracted and feels to the palpating finger quite distinct and hard. This contraction is generally accompanied by colicky pain. After a few seconds, or in some cases a few minutes, the intestine gradually loses its rigidity and the pain disappears. Sometimes as the contraction passes off a distinct gurgle is heard. Such tonic contraction may be caused by striking or rubbing the abdomen, by the ingestion of food, or by psychic influence. Often the patient will describe these attacks with such exactness that a diagnosis of intestinal stenosis is readily made.

The tonic contraction is relieved by the passage of intestinal contents through the stenosed portion, or more frequently by regurgitation. The affected portion of intestine lies quiet until the peristaltic action above drives into it additional fecal matter, and this in turn excites tonic contraction.

Pain of a colicky character is the common accompaniment of tonic contraction. It is not invariable, and it may also occur without visible contraction of the intestine.

The intestinal contraction above described is the most important symptom of intestinal stenosis. It is not an absolute sign, however, since in certain cases of neurosis peristaltic action may be increased and tonic contraction may also occur. But in such circumstances the portion of intestine affected will vary from time to time, while in intestinal stenosis the portion affected is always that immediately above the stenosis. Furthermore, in neurotic contraction dilatation of the intestine will be wanting.

If the dilated intestine is so situated that it can be carefully examined, it will be found to be markedly tympanitic in the period of contraction. Sometimes it can be sharply differentiated from the surrounding coils of intestine by reason of its clear high note, which is similar to that of a dilated stomach. A second indication of dilatation is the splashing sound which can be obtained in the interval between contractions. This is a sound which occurs in the intestine under no other condition except perhaps in acute enteritis, and then it will not be constant in the same place.

Stenosis of the small intestine has no influence upon the character or form of the stools. Their amount and frequency depend upon the degree of stenosis. Constipation is the rule. If diarrhœa is present, it is due to an accompanying catarrh of the large intestine. If the stenosis is situated near the cæcum, diarrhœa may alternate with constipation just as it often does in stenosis of the large intestine.

The urine is scanty and concentrated on account of the interference with intestinal resorption. The quantity of indican in the urine is increased in most cases. From such increase it is not possible to draw reliable inference as to the site or degree of such stenosis.

Stenoses of the small intestine may be multiple, in which case there will be a series of hypertrophied and dilated portions causing the intestine to resemble a string of sausages. Multiple stenoses cannot be differentiated clinically from a single stenosis.

Stenosis of the large intestine, if situated in the neighborhood of the ileocæcal valve, produces symptoms which are similar to those of stenosis of the small intestine because the lower portion of the ileum is involved in the obstruction. A differential diagnosis will therefore depend upon the presence of a palpable obstruction, which in the case of cæcal stenosis can almost always be made out.

Stenosis of the lower portion of the large intestine is characterized by slight symptoms. The intensity of peristalsis of the small intestine is about twenty-five times that of the large intestine. Any obstruction therefore in the small intestine excites the most powerful peristaltic action. Such is not the case in the large intestine, where even a high degree of stenosis may produce no other symptoms than constipation and slight meteorism. Every surgeon of experience must have opened the abdomen for acute ileus and found to his surprise a stenosis of the large intestine which apparently had lasted for months with few symptoms until the obstruction became complete. Careful examination of such a patient will show, however, a local meteorism in both lumbar regions if the obstruction is in the sigmoid colon or rectum. The stools are always altered. There may be obstinate constipation or diarrhœa, or one condition may alternate with the other. The diarrhœa is due to catarrh of the large intestine which is the result of the retention of feces above the stenosis. Small quantities of mucus and fluid portions of the feces constantly pass the stenosis. This fact should be borne in mind so that the mistake shall not be made of diagnosticating stenosis as simple colitis. A ribbon-like condition of the stools may be produced by stenosis in the rectum or lowest portion of the sigmoid colon. The presence of pus, blood, or fragments of tumor is of far greater importance in indicating the nature of the stenosis. If the stenosis is accompanied with ulceration, the stools usually have a most offensive odor. Distention of the rectum with air or water is a valuable means of diagnosis. (See page 36.)

Treatment.—The effect of intestinal stenosis upon the general condition of a patient depends in great measure upon the character of the lesion. The treatment of a cicatricial stenosis may be quite different from that demanded by a tuberculous or carcinomatous stenosis. Intestinal stenosis may injure the patient by depriving him of nourishment and causing pain. Furthermore if the stenosis is a narrow one, it carries with it the risk of acute ileus, while in the dilated portion of intestine ulcers may form which in their turn may lead to perforation and peri-

tonitis. Thus even benign stenoses produce death sooner or later. For these reasons chronic intestinal stenosis wherever situated is a serious affection and one which requires operative treatment. The temptation to postpone operation is peculiarly strong in chronic stenosis unless some complication arises which immediately threatens life.

The operative measures to be considered are:

1. Complete removal of the stenosed portion by resection. This operation is only indicated in malignant tumors whose radical removal seems possible. In tuberculosis and other ulcerative processes the indication for resection is a relative one, dependent not a little upon the technical difficulty of the operation.
2. Simple entero-anastomosis.
3. Complete or incomplete intestinal elimination.
4. Artificial anus.

The technic of these operations, and the special indications for their performance, are given on pages 458 *et seq.*

The most important feature of non-operative treatment for intestinal stenosis is the patient's diet. Solid indigestible substances may change an incomplete into a complete stenosis. In stenosis of the small intestine laxatives work injury by unnecessarily increasing peristaltic contraction, and they are not of service in making fecal matter fluid as it is constantly so in the small intestine. Sometimes opium is of benefit under these circumstances. If constipation exists, it should be relieved by enemata.

In stenosis of the large intestine suitable laxatives may be of great benefit. Usually salines in combination with enemas act favorably to facilitate the passage of feces through the stenosed portion.

GASTRIC ULCER AND ITS COMPLICATIONS.

A gastric ulcer may involve the mucous membrane only or also the deeper layers of the stomach. It shows little tendency to heal, so that it may remain about the same size for months, or even years; or it may gradually increase in size. Gastric ulcer is classified into simple ulcer (round or chronic or peptic ulcer) and traumatic ulcer. Carcinomatous ulcer is spoken of under a subsequent heading.

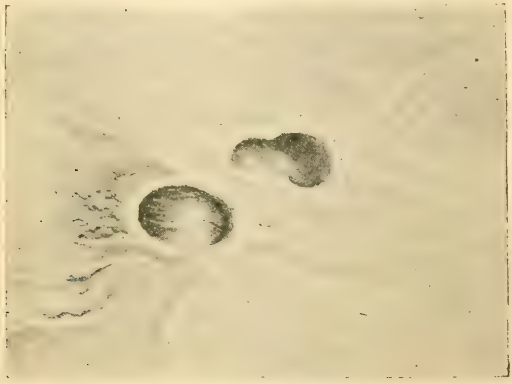
Pathological Anatomy.—Little is known of the exact causes of gastric ulcer, but probably the gastric juice has something to do with the formation of a simple ulcer since it only occurs in places which are accessible to the acid gastric juice. For example, in the stomach itself, in the lower portion of the œsophagus, in the upper portion of the duodenum, and in a loop of small intestine that is connected to the stomach by gastro-enterostomy. It is evident that the gastric juice alone cannot produce ulceration, and there are numerous cases of hyperacidity in which no ulcer is found. There must be some factor which impairs the nutrition of the gastric wall before an ulcer is formed. Traumatic defects in the mucous membrane of the stomach, such as those produced by operations upon the organ, usually heal

quickly without giving rise to ulcer. Spasm of the pylorus cannot be looked upon as a universal cause of simple ulcer since it may exist in common with ulcer of the duodenum. In such cases it is doubtless the result of an ulcer, and not its cause. Moreover, if a gastric ulcer were due to spasm of the pylorus and the resulting changes in motor action of the stomach and the composition of the gastric juice, a cure of the ulcer ought to follow gastro-enterostomy or pyloroplasty. Such cure does not always result. One must admit that the etiology of simple gastric ulcer is not yet clear, while the relations between ulcer, hyperacidity, motor disturbances, and spasm of the pylorus also need further explanation.

Gastric ulcer is a common disease. It is reckoned that it affects from 1.23 to 13 per cent. of the population in different localities. It is twice as common among women as among men. It is rarely seen in childhood. Most of the patients are women between fifteen and thirty or forty years of age, while most of the men affected are between thirty and forty-five years of age. It may also occur at an advanced age.

A simple ulcer is usually situated in the posterior wall of the stomach and in the pyloric half of the lesser curvature. (Fig. 74.)

FIG. 74.



Two ulcers in the small curvature of the stomach, base formed by muscular coat. (Richardson.)

In this comparatively small area are found four-fifths of all simple gastric ulcers. The percentage for the different portions of the stomach are, posterior wall 40 per cent., pyloric portion 25 per cent., lesser curvature 15 per cent., and rest of the stomach 20 per cent. Only 20 per cent. of ulcers are found in the anterior wall. In some cases two or more ulcers coexist.

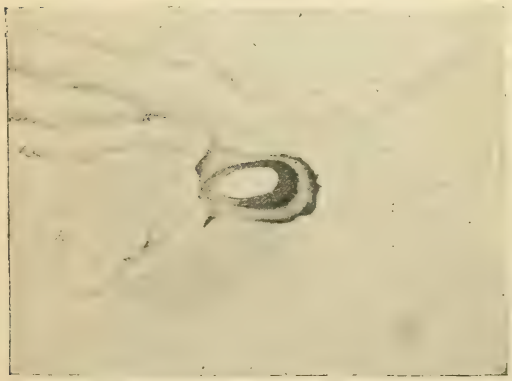
A gastric ulcer varies in size and depth. It may measure several inches in diameter. It is usually round or oval, but may have an irregular shape. In a few cases an ulcer has been found extending completely around the pylorus. The edge of the ulcer is sharp but not elevated, and rarely undermined. Indeed, if the ulcer involves

the deeper layers it is usually funnel-shaped, since each deeper layer is destroyed less extensively than those superficial to it. The depth of the ulcer is not at all dependent upon its extent.

Microscopical examination of a fresh ulcer shows that its base and edges are infiltrated with round cells, while in an old ulcer a good deal of connective tissue is seen between the glands and the other normal structures. Consequently an old ulcer is hard, sometimes almost as hard as a cancer. If the ulcer has existed a short time, the rest of the wall of the stomach is normal or nearly so. In case of hyperacidity or gastric catarrh the mucous membrane will show the changes usually found with these conditions. At a later period of the disease the mucous membrane may be much atrophied. The muscular portion of the stomach may be hypertrophied as a result of pyloric stenosis. Otherwise the thickness of the stomach-wall is normal or even less than normal if the ulcer is large. In this respect the effect of the disease is different from that of carcinoma, since in the latter affection the gastric wall is often abnormally thick even though the stomach be dilated.

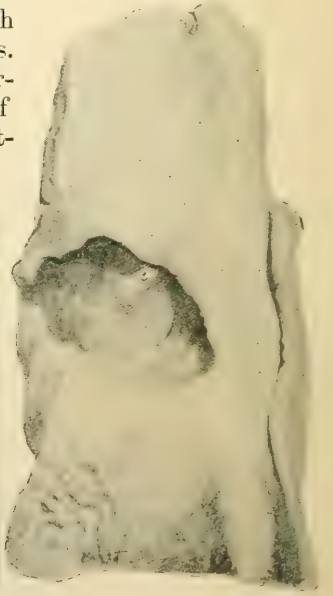
The region of the ulcer is usually hyperæmic, and there is often in addition a hyperæmia of the pyloric region even though the ulcer is not situated near the pylorus. At operation the pylorus is found moderately or firmly contracted irrespective of the seat of the ulcer. The muscular structure of the stomach, and especially that near the pylorus, is abnormally sensitive, responding to slight irritation by vigorous peristaltic contraction.

FIG. 75.



Perforating ulcer of the stomach. (Richardson.)

FIG. 76.



An ulcer of the stomach, showing at its base the open orifice of a vessel: death from hemorrhage. (Richardson.)

As the ulcer approaches the serosa circumscribed peritonitis results, and if the stomach becomes adherent to the adjacent parts the ulcer may extend through the wall of the stomach and involve the pancreas,

or liver, or anterior abdominal wall. If firm adhesions are wanting, perforation may take place into the free peritoneal cavity or into some portion of the peritoneal cavity which is shut in by adhesions. (Fig. 75.) Protecting adhesions are less likely to form between the stomach and anterior abdominal wall on account of the constant respiratory motion. The ulcer may also perforate into the pleura, pericardium, colon, or spleen. The immediate cause of perforation may be a slight or severe traumatism, or some error in diet.

The perigastritis due to ulcer may lead to well-marked induration so that the scar-tissue may easily be mistaken for a new growth. The adhesions may be firm enough to prevent the escape of gastric contents into the free peritoneal cavity, although they cannot prevent the gradual extension of the process. The patient will then suffer from a subacute infectious perigastritis with symptoms varying according to the situation of the ulcer. Such a condition may be recovered from, the exudate being resorbed while nothing but extensive adhesions mark the site of the trouble. Or a circumscribed abscess may be left which at a later date may perforate into the peritoneal cavity or some neighboring organ or space. The commonest cause of subphrenic abscess of the left side is subacute perigastritis.

Hemorrhage occurs in about 50 per cent. of the cases of simple ulcer. It would occur still more frequently if the thrombosis did not block the affected vessels. The vessels of the gastric wall give rise to small hemorrhages which may be frequently repeated. Profuse hemorrhage is due to erosion of one of the large arteries, usually the gastric or one of its branches, or the pancreatic, less often the splenic or hepatic arteries. (Fig. 76.)

If the ulcer has involved only the superficial portion of the mucous membrane, it may heal without a scar. If it involves the whole thickness of the mucous membrane, its healing leaves a certain amount of scar-tissue which is covered with mucous membrane. An ulcer which extends into the muscular or serous coat heals with a deep connective-tissue scar, since the muscular tissue is never regenerated. Such a scar is usually covered with a single layer of cylindrical epithelium. New ulcers may be formed either in the scar or elsewhere, and sometimes carcinoma develops either in the scar or in the base of an open ulcer. If the scar is situated in or near the pylorus, its contraction may produce stenosis by narrowing or kinking the outlet of the stomach. If the scar is in the body of the stomach and is very extensive, its contraction may produce hour-glass stomach. Cicatricial adhesions following perigastritis may pull upon the stomach and disturb its functions.

Symptoms.—The symptoms caused by gastric ulcer vary according to the size, depth, and situation of the ulcer, the sensitiveness of the individual, and the presence of hemorrhage, perigastritis, or other complications. Thus two ulcers which to all appearances are exactly alike may produce in one patient severe symptoms and in the other none at all. The general condition of the patient depends upon his ability to absorb nourishment and upon the existence or non-existence of hemor-

rhage. If the diagnosis is doubtful and the patient is much emaciated, the lesion is probably a severe ulceration or carcinoma. Such emaciation may also occur with chronic gastritis, gastric atrophy, and even as a result of neurosis. Anæmia and chlorosis are common accompaniments of ulceration. Pulmonary tuberculosis frequently exists, and about 20 per cent. of the patients who have suffered for some time from gastric ulcer die of pulmonary disease. Nervous symptoms are common. So are dyspeptic symptoms, although there is nothing characteristic about them. Constipation is the rule. Diarrhœa is rarely seen in connection with gastric ulcer.

Local pain or burning is a common symptom which may occur spontaneously or be produced by taking food. It is often increased by pressure. Still, in many cases of ulcer pain is wanting, while it also occurs as a symptom of gastric neurosis, carcinoma, gastritis, or gastroptosis. Diseases of the pancreas and duodenum and cholelithiasis may also cause pain not usually to be distinguished from that due to gastric ulcer.

Hemorrhage is the only positive symptom of gastric ulcer, and this is frequently wanting. Leube observed hemorrhage in 46 per cent. of his cases. Müller says it was present in 120 cases which came to autopsy, it being the cause of death in 14 of these cases. Welch estimates that from 3 to 5 per cent. of patients having a gastric ulcer die from hemorrhage. For practical purposes hemorrhage may be spoken of as severe or slight. Severe hemorrhage comes from a large vessel and often causes death. In a few instances it is followed by pernicious anæmia. A slight hemorrhage soon stops so that it does not immediately threaten the life of the patient. If the thrombus is digested by the gastric juice, the hemorrhage may recur. In this way even a slight hemorrhage may recur many times until it produces an extreme degree of anæmia and even death. If the quantity of blood is small, vomiting may not be produced. Even though there is no vomiting the blood may appear in the stools, giving a characteristic tarry appearance. A very small hemorrhage is likely to be overlooked unless a microscopical or microchemical examination is made. Very severe hemorrhage produces the symptoms of acute anæmia, and in this way bleeding may often be recognized even though the patient does not vomit.

Gastric hemorrhage is not an absolute sign of ulceration, since it may occur in cases of portal congestion or thrombosis of the portal vein. There is also a parenchymatous hemorrhage of hæmophilia and hysteria. The hemorrhage from a gastric carcinoma is usually slight and frequently repeated. The blood can easily be found in the vomited material.

Gastric ulcer often produces motor disturbances of the stomach. If it is situated near the pylorus, the cicatricial tissue which it causes may produce stenosis, or stenosis may be caused by the spasmodic contraction of the muscles, or by infiltration of the wall due to fresh ulceration. Even when the normal calibre of the pylorus is pre-

served, adhesions may interfere with passage of the stools. An ulcer although situated at some distance from the pylorus may disturb the motor action of the stomach on account of the reflex pyloric spasm or weakening of the general muscular system. In most cases of gastric ulcer there is hyperplasia of the pylorus, whereas even in the early stages of carcinoma there is well-marked gastric atony.

Riegel calls attention to the hyperacidity of the gastric juice in case of gastric ulcer. This was present 16 times in 21 cases of gastric ulcer in which diagnosis was established by laparotomy. Very rarely is there less than the normal acidity. These changes in acidity are not dependent upon the age of the ulcer. Hyperacidity may also exist in case of carcinoma which has developed in the base of an ulcer, in case of benign stenosis, and in case of gastric neurosis; consequently this symptom is only of relative value, although it is much commoner in connection with gastric ulcer than with other gastric affections. Excess of gastric juice is also common with gastric ulcer, as it is with other gastric affections.

Simple gastric ulcer may be palpable as a tumor either because the hypertrophied and contracted pylorus is itself palpable or because of perigastritis. In the last case the area of resistance will be more diffuse. If the ulcer is so situated that the stomach becomes attached to the anterior abdominal wall, the area of resistance is especially well marked. If the ulceration attacks the abdominal wall, the condition may be mistaken for a tumor of the abdominal wall itself, although the history of the patient and an inquiry for other symptoms of ulcer will prevent such a mistake. Such an adhesion to the abdominal wall will produce great pain either spontaneously or when the patient moves, or takes food, or when the abdominal wall is pressed upon. Contraction of a portion of the rectus muscle in the neighborhood of such a tender spot may also simulate a tumor. (See page 234.) In general, however, the presence of a tumor suggests carcinoma rather than ulcer.

An important complication of gastric ulcer is perforation into the free peritoneal cavity. This may occur spontaneously or as the result of traumatism. Sometimes perforation occurs in a patient who is known to have a gastric ulcer, and sometimes it occurs in an individual who has not considered himself sufficiently ill to seek medical advice. The symptoms produced by perforation of gastric ulcer are the same as those produced by traumatic rupture of the stomach. (Page 257.) There are wanting, of course, the shock of traumatism and the effects of injury of the abdominal wall. Perforation produces intense pain, usually limited at first to the immediate vicinity of the opening in the stomach. The abdominal muscles are firmly contracted. There may be pronounced collapse. The pulse is usually small and rapid. These symptoms gradually pass into those of diffuse peritonitis.

The symptoms produced by a gastric ulcer are by no means uniform. They may be scarcely noticeable, or merely dyspeptic symp-

toms until some complication, such as perforation or hemorrhage, arises. Or the ulcer may heal after months or years and leave the diagnosis in doubt unless the patient dies from some other cause, and at autopsy a freshly healed ulcer of the stomach is found. In other cases the patients suffer from severe disturbances of the stomach, intense pain, and repeated hemorrhages until their strength is exhausted and they are eager to die. Repeated hemorrhage may produce acute or chronic anæmia which may take on a pernicious form. Stenosis of the pylorus may lead to marked emaciation, perforation of the ulcer, perforative peritonitis or perigastritis, and subphrenic abscess. Furthermore, every old ulcer exposes the patient to the risk of carcinoma, since from 3 to 5 per cent. of the cases of gastric carcinoma develop in the base of chronic ulcers. An additional reason why radical surgical treatment of ulcer is justifiable is the fact that about 20 per cent. of patients who suffer a long time from this trouble contract pulmonary tuberculosis with fatal result.

The mortality of gastric ulcer is reckoned with difficulty on account of the uncertainty of the diagnosis. Leube gives it as 2.4 per cent., and Debove and Remond as 50 per cent. Such a wide difference of opinion may be due to the condition in which patients have been observed in hospital or private practice, to the uncertainty of diagnosis, to recurrence after apparent cure, etc. Perhaps an estimate of 25 per cent. as a mortality from the disease will not be wide of the mark. Certainly as many as 25 per cent. of the patients who suffer from gastric ulcer can be permanently cured by proper surgical treatment. The diseases which may be confounded with gastric ulcer are as follows:

1. Carcinoma. More often than is generally supposed, a suspected ulcer of the stomach proves by operation or by subsequent course of the disease to be carcinomatous.

2. Diseases of the gall-bladder and biliary vessels may simulate gastric ulcer. A gall-stone may become wedged in the cystic duct and by perforation or otherwise set up inflammation. It may lead to adhesions which involve the liver, duodenum, transverse colon, or even the stomach. In the presence of such a tumor, and especially if there is no jaundice, a diagnosis of gastric ulcer is easily made. Perhaps the duodenum or pylorus is pressed upon or drawn aside by the adhesions, so that symptoms of pyloric stenosis are added. A gall-stone may also perforate into the duodenum, and in various other ways disease of the biliary passages may lead directly or indirectly to gastric disturbances.

3. Epigastric hernia may interfere with the functions of the stomach. Search should be made for this condition in every case of gastralgia.

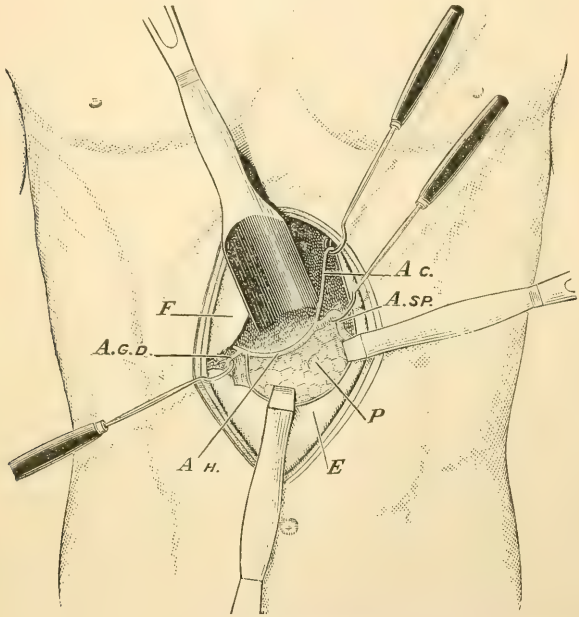
4. The question of ulcer of the duodenum should be considered, especially if the patient is a male.

5. In some instances no positive diagnosis can be made even after the abdomen has been opened. There are cases of hysteria and neu-

rasthenia and nervous dyspepsia accompanied by hyperacidity, primary gastric atony, etc., which may lead the surgeon into diagnostic error. The question will then be raised whether some further operation ought to be performed. If the stomach is dilated without pyloric stenosis, gastro-enterostomy is indicated, but experience has shown that in the absence of evident cause for the symptoms operation upon the stomach is not likely to benefit the patient and frequently aggravates the symptoms present.

Treatment.—Operative treatment may be demanded for the cure of simple gastric ulcer or on account of some complication. The treatment of the complications is relatively simple. A perforation should be

FIG. 77.

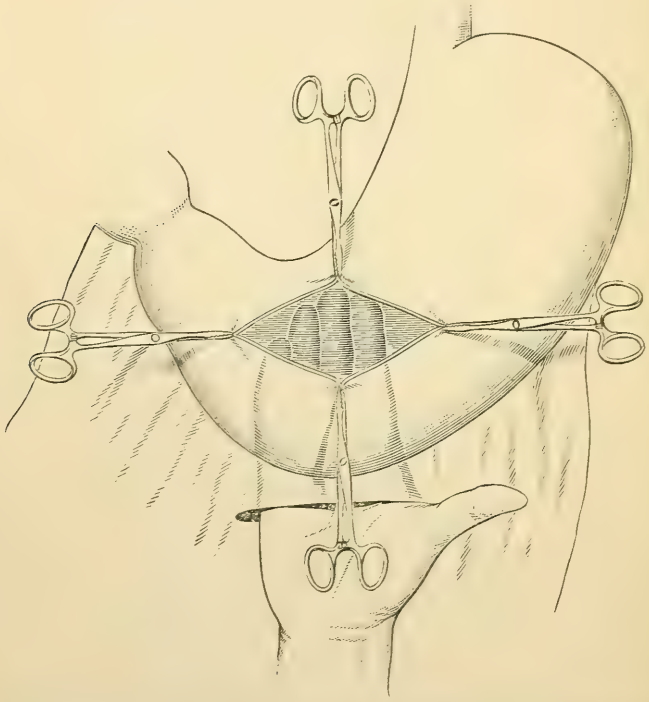


Ligation of the splenic artery for gastric hemorrhage: *F*, liver; *P*, pancreas; *E*, stomach, drawn downward; *A. c.*, gastric artery; *A. sp.*, splenic artery; *A, h.*, hepatic artery; *A. g. d.*, gastro-duodenal artery. (Terrier.)

sutured, a bleeding vessel should be ligated either at the place of hemorrhage or at a distance, and stenosis of the stomach or pylorus should be overcome by a plastic operation or by gastro-enterostomy. The treatment of the ulcer itself is not so clear. Whether incision of a simple ulcer and suture of a gastric wound will be followed by permanent cure is not yet known with certainty. Such an operation has seldom been performed when no complications existed. Only a small portion of the stomach is easily accessible and comparatively few ulcers are situated there. Ulcers of the smaller curvature or posterior wall not infrequently involve the pancreas, while those that are in or near the pylorus are often complicated with pyloric stenosis and require pyloroplasty or gastro-enterostomy.

Simple excision is not likely to produce a permanent cure of gastric ulcer, a disease in which three abnormal conditions are usually present, namely, hyperacidity, pyloric spasm with or without narrowing of the pylorus, and ulcer itself. It should be added that the three conditions are intimately associated. If the narrowing or spasm of the pylorus be overcome, the hyperacidity disappears and the ulcer heals in a majority of cases. At least, symptoms due to it disappear, so that one may fairly assume that it is healed. Consequently surgical treatment ought to overcome or circumvent the pyloric contraction by a pyloroplasty or gastro-enterostomy. If the ulcer is accessible, it may be excised, but the almost certain cure of these patients by gastro-enterostomy alone makes other operation unnecessary.

FIG. 78.



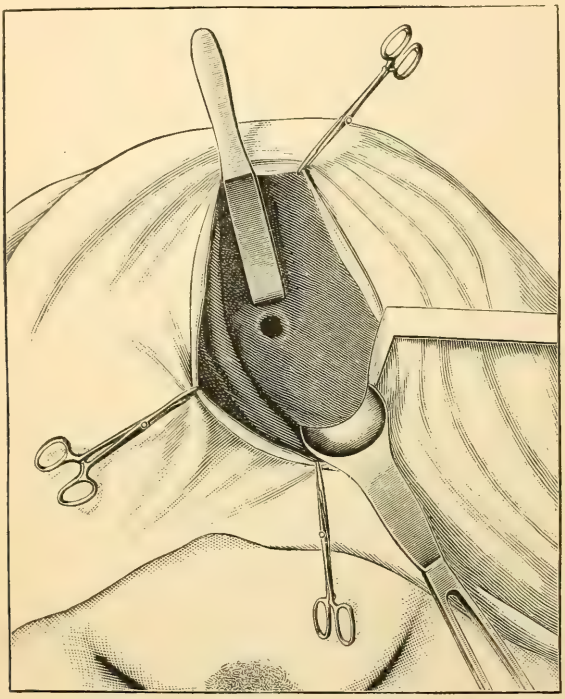
Exploration of the stomach for gastric hemorrhage; stomach opened—hand in lesser peritoneal cavity. (Terrier.)

As stated above, operation may be required on account of the three severe complications, hemorrhage, perforation, stenosis, and also on account of adhesions or the severity of the symptoms of uncomplicated ulcer:

1. Operation may be required after a single hemorrhage which continues in spite of internal remedies and threatens the patient's life, or on account of repeated small hemorrhages which have produced a chronic anæmia. While repeated attempts have been made to find

and ligate the bleeding vessel, only a few surgeons have succeeded. (Fig. 77.) Sometimes the ulcer situated in the posterior wall has already involved the substance of the pancreas so that ligation is out of the question. Successful attempts at ligation have been reported by Roux, Mikuliez, and Witzel. If the eroded vessel lies in the substance of the pancreas, the base of the ulcer may be cauterized or tamponed. If a tampon is employed, the stomach must be left open and a jejunostomy performed to provide for the patient's nourishment. (Figs. 78, 79.) In other cases it is difficult to find the ulcer either

FIG. 79.



Exploration of the stomach for hemorrhage—ulcer in posterior wall exposed. (Terrier.)

because the ulcer is small or hidden in scar-tissue or situated in the region of the cardia. Under such circumstances tamponade of the whole interior of the stomach with accompanying jejunostomay may be considered.

One of the greatest difficulties in the treatment of these cases is to determine whether the hemorrhage which has taken place is so great that any further bleeding will cost the patient's life. One is inclined to wait with the hope that further hemorrhage will not take place, and if it does so the patient may be too weak to stand operation. Moreover, there are instances of spontaneous recovery after hemorrhage which has produced severe collapse: but it is not well to trust to such

spontaneous cure, since 5 per cent. of all patients having gastric ulcer die of hemorrhage.

In view of the uncertainty which attends direct ligation of the bleeding vessel, the proper method of procedure in most cases is an indirect cure of the ulcer by placing the stomach at rest. This may sometimes be accomplished by jejunostomy, which, according to the experience of Heidenhain and others, is a successful operation. No nourishment should be given by mouth for several weeks. It can then be commenced and gradually increased, but not until the stomach proves its ability to handle the full amount of nourishment without fresh hemorrhage is the fistula allowed to close. The shock of this operation is very slight even in a previously anæmic patient. (Page 455.) If the patient's condition warrants it, pyloroplasty or gastro-enterostomy should be performed in addition to the jejunostomy so as to render less likely a new ulceration. Internal treatment with bismuth, etc., should not be neglected.

In case of frequently repeated small hemorrhage the conditions are somewhat different. In such a case one may wait to learn whether internal treatment is capable of stopping the hemorrhage. If it fails, the necessity for operation is sufficiently clear. One ought not, of course, to wait until the anæmia is too pronounced. Operation is demanded less to stop the hemorrhage than to heal the ulcer. If it is accessible, it should be excised, otherwise gastro-enterostomy or pyloroplasty should be performed. The latter operation is indicated if the ulcer to be excised is situated at or near the pylorus. In other respects the operation is similar to that for uncomplicated gastric ulcer.

2. If a gastric ulcer perforates into the free abdominal cavity, laparotomy and suture of the perforation are absolutely indicated. The statistics given on page 221 show the rarity of spontaneous recovery and the advantage of early operation. The symptoms of perforation in many cases are so sudden and pronounced that the diagnosis is nowise in doubt. At other times they are such as to suggest that a perforation is imminent but has not taken place. In these doubtful cases some authors advise delay, but the risk of operation is far less than that of perforation, and as 80 per cent. of perforations occur in the anterior wall of the stomach and are therefore easily accessible, an exploratory laparotomy is the better practice in cases of doubt.

The technic of suture of perforation of the stomach is described on page 412. If the opening cannot be closed by direct suture, it may be covered with omentum or other tissue (page 411); or a tampon may be used and temporary jejunostomy performed.

If the perforation is not a sudden one, but is preceded by a perigastritis, there is less need for immediate operation and the patient can be closely watched. Spontaneous recovery is not infrequent. Or, an abscess may be formed in the subphrenic space or elsewhere which will require to be opened. Another reason for delaying operation in these cases is the inaccessible situation of the ulcer in the lesser curvature or poste-

rior gastric wall. To reach such an ulcer, one must break up adhesions and run the risk of infecting the general peritoneal cavity. Furthermore, adhesions make it difficult to find the ulcer, and when found, its closure by suture may be impossible. When a perigastric abscess has been diagnosticated, it must be opened no matter where situated. The most favorable point for drainage is usually shown by the aspirating-needle.

3. If the ulcer leads to stenosis of the pylorus or to stenosis of the stomach itself (hour-glass stomach), an operation is necessary. This may be either a pyloroplasty or a gastroplasty, a gastro-anastomosis, or a gastro-enterostomy.

4. Adhesions between the affected portion of the stomach and the abdominal wall or neighboring organs may require operative treatment. If the adhesions are slight, the motion of that portion of the stomach will be interfered with, and when the stomach is distended the patient may suffer considerable pain similar to that felt in epigastric hernia. A correct diagnosis is not easily made. It is difficult to explain why many operations upon the stomach which must be followed by adhesions lasting a certain time are followed by no pain whatever, whereas in other cases adhesions give rise to intense pain which disappears when they are divided. This operation is spoken of as gastrolysis. (Page 411.)

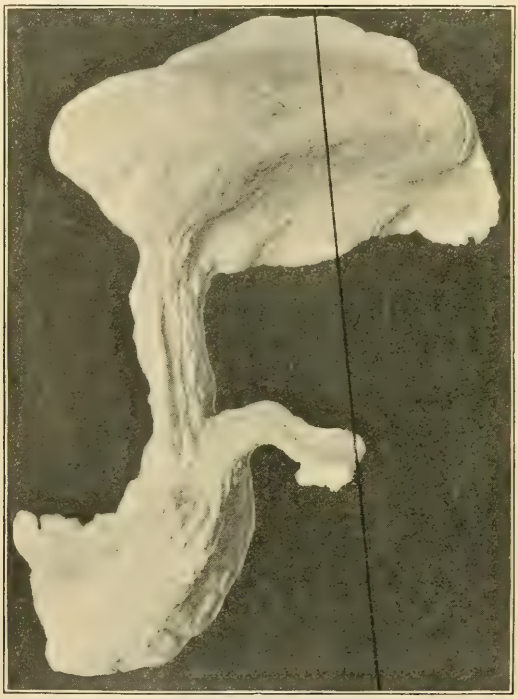
In other cases the adhesions are so firm that the diagnosis is easily made but the operation is difficult. Thus the stomach may become so firmly attached to the anterior abdominal wall that the ulcer extends into the muscular planes or may penetrate the whole thickness of the abdominal wall. In such a condition extreme pain is caused by direct pressure or by any motion which tends to displace the adherent stomach. Operation is plainly indicated, and should include resection of the ulcer and of the affected portion of the abdominal wall, closure of the stomach by suture, and, finally, suture of the gap in the abdominal wall. The operation is rendered particularly difficult if a considerable extent of the gastric wall is infiltrated, or if the perforation extends into the liver or some other organ. A gap which cannot be closed by suture may be stopped by omentum or tamponed with gauze. The complication of an external gastric fistula does not materially change the nature of the operation.

5. In addition to the four urgent causes for operation mentioned above, there is a fifth class of cases in which complications do not threaten life, but in which the patient is constantly annoyed by pain, vomiting, and lack of nutrition, in spite of a carefully regulated diet and mode of life. If such a patient has been treated medicinally for a reasonable length of time without benefit, and is obliged to earn his living, the indication for operation is sufficiently clear, as mentioned in the preceding pages. Simple excision of the ulcer will often not cure the patient, since the disposition to new ulceration still exists. Furthermore, the ulcer is usually so situated that it is difficult or impossible to remove it. The proper procedure is therefore to facilitate the

escape of gastric contents by a pyloroplasty or gastro-enterostomy. If the ulcer is accessible, it should be removed at the same time.

The effect of pyloroplasty or gastro-enterostomy in these cases is shown by experience to be as follows: Motor disturbances which exist at the time of operation whether due to cicatricial stenosis, spasm of the pylorus, or atony, are overcome either immediately or gradually. The effect of operation on hyperacidity is to diminish it whether an ulcer is excised at operation or not; for an ulcer which is not excised has a tendency to heal after operation. Pain, tenderness, and other symptoms disappear either immediately or gradually. Symptoms may

FIG. 80.



Cast of hour-glass stomach, seen from above. The black line indicates the median line of the body. The posterior pouch is connected with the œsophagus. (Dwight.)

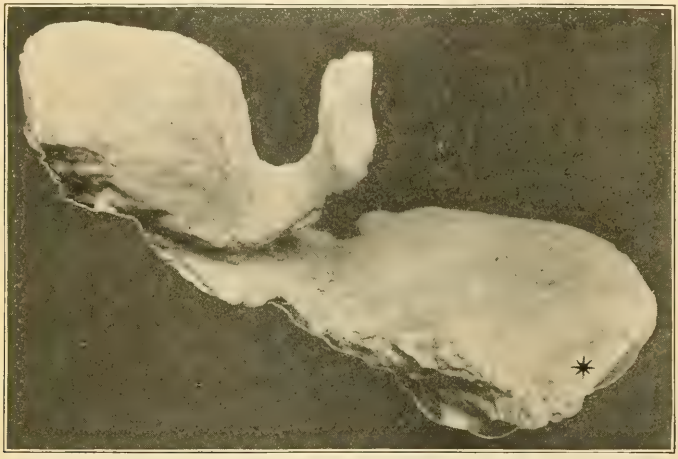
recur, but only in a minority of cases, and the criticism which has sometimes been made, that improvement only lasts so long as the patient is careful in regard to his diet, is disproved by experience. No patient should be considered completely cured unless he can eat and drink like a normal, healthy man.

It is to be admitted that both gastro-enterostomy and pyloroplasty sometimes fail to effect a cure or to prevent recurrence after a period of temporary relief. There were 3 such cases in a series of 50 patients operated upon by Mikulicz and watched for a considerable period

of time. In 3 other patients relieved by gastro-enterostomy ulcers subsequently developed in the loop of jejunum which was anastomosed with the stomach. Such erosion of the intestinal mucous membrane is due to the unnatural presence of the acid gastric contents, and it is a condition which surgery has thus far failed to relieve, jejunostomy having been tried without effect. Such intestinal ulceration is less likely to occur after pyloroplasty.

At the present time the majority of surgeons prefer gastro-enterostomy to pyloroplasty because of their belief that recurrence more often follows the latter operation. The experience of Mikulicz tends to prove the contrary, and, as above stated, peptic ulcer of the jejunum sometimes follows gastro-enterostomy. The counterindications are given on page 426.

FIG. 81.



Cast of hour-glass stomach, seen from the right and behind, showing the inclination of the long axis. The star marks the pylorus. (Dwight.)

If gastric ulcer is accompanied by stenosis of the body of the stomach, gastroplasty or gastro-enterostomy should be performed. (Figs. 80 and 81.) If there is at the same time spasm or stenosis of the pylorus, pyloroplasty or gastro-enterostomy may be performed. If the upper half of the stomach is sufficiently large, the simplest method of procedure is to anastomose it with the jejunum, leaving undisturbed the stenosis of the stomach or the pyloric contraction.

If the ulcer is situated in the neighborhood of the pylorus, it may be removed by a circular resection of the pyloric portion of the stomach, but this operation on account of its magnitude should not be performed for ulcer alone. Resection when the stomach is movable is a serious operation, and becomes much more so if the stomach is adherent to the pancreas or elsewhere. If there is suspicion that the base of the ulcer is carcinomatous, resection of the ulcer is justifiable.

Under circumstances which do not permit of a more radical opera-

tion rest can be afforded the stomach by gastro-enterostomy, or still more perfectly by jejunostomy.

The results of operations for benign gastric lesions are far better than formerly. According to statistics collected by Mikulicz, the mortality after operation up to the year 1885 was 43 per cent., whereas from that time to 1897 it was only 16 per cent. In the period from 1891 to 1897 the mortality of resection was 27.8 per cent., gastro-enterostomy 16.2 per cent., and pyloroplasty 13.2 per cent. The figures of still more recent operations are even more favorable, and, as might be expected, the results of single operators are better than collected statistics; thus, 40 patients were operated upon in Mikulicz's clinic between 1897 and 1899 for benign gastric affections. Only 3 of them died as a result of operation, a mortality of 7.5 per cent.

The statistics given show the mortality which is directly due to the operation. The later results of operation are not so easily determined. In order to determine the effect of the operation upon the disease it is necessary to keep a patient under observation for years. When this has been done, one can properly say whether a patient has or has not been cured. The ulcer may exist for a long time without giving rise to symptoms and then suddenly reveal its presence by hemorrhage or perforation. On the other hand, dyspeptic symptoms may last long after the ulcer has healed. Such a patient may be cured of his ulcer, but he cannot be spoken of as perfectly well.

Such considerations as these render it difficult to say just what are the results of surgical treatment or how they compare with the results of non-operative treatment; but one is justified in concluding:

1. The effect of operation is excellent in every sort of stenosis of the stomach or pylorus when due to a fresh ulcer or to cicatricial tissue.

2. A good result usually follows pyloroplasty or gastro-enterostomy, in gastric ulcer unaccompanied by stenosis. In some cases, however, unpleasant symptoms persist after operation or recur after a period of apparent cure. In a very few cases operation seems to have no effect.

GASTRECTASIA.

There are certain other non-malignant troubles of the stomach which may require operation. First of all, there is the ectasia of the stomach due in most cases to stenosis of the pylorus. It may, however, be caused by pressure of tumors or diseases of the pylorus or duodenum. These cases of secondary ectasia are to be distinguished from the primary ectasia without pyloric obstruction. It is in such cases that some surgeons have reduced the size of the stomach by enfolding into its cavity one or more folds of its wall. Whether or not this is a better procedure than gastro-enterostomy, it is not easy to state.

CELLULITIS AND ABSCESS OF THE STOMACH.

Simple gastric ulcer must sometimes be differentiated from hemorrhagic erosions, or from very rare tuberculous or syphilitic or typhoid ulcers. Anthrax pustules have also been known to occur in the stomach.

Abscess of the stomach occurs, usually of metastatic origin. Cellulitis is rarely the result of simple ulcer. It is more likely to occur in connection with carcinomatous ulcer, or it may be due to traumatism or foreign body. Both abscesses and diffuse cellulitis have their seat in the submucosa, usually at the pyloric portion. The pus may break through the mucosa into the stomach or through the serosa into the peritoneal cavity. The symptoms are those of acute gastritis together with symptoms of peritonitis. Cellulitis of the stomach can scarcely be differentiated from subacute perforating ulcer, but the distinction is not of much importance since either requires operative treatment. The affected portion of the gastric wall should be exposed, walled off from the general peritoneal cavity, and incised if necessary.

NERVOUS GASTRIC SPASM.

There is a neurosis of the stomach which may occur independently or in connection with hyperacidity, spasm of the pylorus, or gastric dilatation. Experience has shown very clearly that such patients should not be operated upon. As the symptoms are similar to those produced by gastric ulcer, it is well to have this neurosis in mind lest one by useless operation aggravate the symptoms of the patient.

PEPTIC ULCER OF THE DUODENUM AND JEJUNUM.

A peptic ulcer may occur in the duodenum as well as in the stomach. It does not occur elsewhere in the intestine presumably because of the mixing of bile and pancreatic juice with the gastric juice. If gastric juice passes directly into the jejunum as a result of gastro-enterostomy, typical peptic ulcers may be there produced. In such cases the gastric juice will usually be found to contain an excess of acid. The etiology, pathology, anatomy, and course of the duodenal ulcer are similar to those of a gastric ulcer. It is far less common than gastric ulcer, occurring in about the proportion of 1 to 9 according to Trier, and 1 to 40 according to Andral. For some unknown reason four times as many men as women are affected. The majority of the patients are between thirty and forty years of age, although some of them were over eighty years of age and others were children. Nearly one-half of the cases observed in children occurred in the first few weeks of life.

Ulcer of the duodenum not infrequently follows extensive burns or frost-bites of the skin. Such ulcers may develop within forty-eight hours after the burn, and if they occur at all, they usually develop within one or two weeks. They may lead to speedy death from hemor-

rhage or perforative peritonitis. The cause of these ulcers is unknown. Equally obscure is the occurrence of embolic duodenal ulcers after laparotomy. (See page 226.)

Collin, who collected reports of 262 cases of duodenal ulcer, found the ulcer to be situated in the superior portion of the duodenum in 242 cases, in about a third of which it was close to the pylorus; 14 times it was in the descending portion. Its occurrence in the anterior wall is almost twice as frequent as in the posterior wall. The frequency of perforation is given by Collin as 69 per cent. and by Chvostek as 43 per cent. Perforation may take place into the peritoneal cavity, or, less often, into the liver, pancreas, gall-bladder, or some large vessel.

Symptoms.—The symptoms of duodenal ulcer are essentially those of gastric ulcer. In typical cases the pain is felt slightly to the right of the median line, and is usually more or less closely associated with the taking of food. It does not come on immediately after nourishment is taken, but a little later, corresponding to the time which elapses before food passes through the pylorus. Loss of appetite and other symptoms which are prominent with gastric ulcer may be wanting. Blood appears in the vomit or stools in about one-third of the cases. If hemorrhage occurs, it is apt to be severe. The vessels whose erosion may produce hemorrhage in the order of frequency are as follows: the pancreaticoduodenal artery, the gastro-epiploica-dextra, the pancreatic and portal veins, the aorta, the hepatic artery, the superior mesenteric vein. Small repeated hemorrhages may also occur as in the case of gastric ulcer. There is usually hyperacidity of the gastric contents. Absence of hydrochloric acid has been mentioned by Robin. If the ulcer leads to cicatricial contraction, motor disturbances may be the result; or these may be due to pyloric spasm. Stenosis is, however, a rather infrequent symptom. The effect of stenosis is quite different according as it is situated above or below the papilla of Vater. (See page 296.) Jaundice may be present if the ulcer is situated at the papilla, or it may be due to the duodenitis which accompanies the ulceration. It is, however, of rare occurrence.

Complications.—The complications of duodenal ulcer are hemorrhage, stenosis, and perforation. Perforation into the free peritoneal cavity is similar in its effects to gastric perforation. Sometimes the peritonitis becomes encapsulated and sometimes perforation produces periduodenitis, and sometimes perforation takes place into a neighboring organ. The escaping contents of the duodenum may collect between the transverse colon and the liver, and the fluid may extend along the ascending colon until it reaches the right iliac fossa and pelvis. Under such circumstances a differential diagnosis with peritonitis starting from the gall-bladder or appendix must be made. If the perforation takes place in the posterior wall of the duodenum, where it is not covered with peritoneum, a septic abscess will result, which not infrequently leads to emphysema of the skin. Perforation may also lead to a subphrenic abscess, usually of the right side. Ulcer of the duodenum may also without perforating produce abscess in the liver.

Duodenal ulcer even more frequently than gastric ulcer may pursue a latent course, being unrecognized until hemorrhage or perforation occurs. At other times uncomplicated ulcer produces very severe symptoms. Perry cites the records of 70 autopsies in which healed or open ulcer of the duodenum was found. In 20 of these cases the ulcer was the cause of death. In only 8 of them was the ulcer completely healed.

Diagnosis.—The diagnosis of ulcer of the duodenum is more difficult to make than that of ulcer of the stomach. The diseases which must be considered in differential diagnosis are ulcers of the stomach, ulcers of the intestine other than the duodenum, cholelithiasis, and appendicitis.

Treatment.—The surgical treatment of ulcer of the duodenum rests upon the same general principles as that of ulcer of the stomach. Pagenstecher, who collected reports of 28 cases of operation for perforation, found a mortality of 86 per cent. In only 12 of these cases was the perforation found and sutured. Landerer and Glücksmann saved a patient in whom they were unable to find the perforation, by suturing together around the site of the perforation stomach, transverse colon, omentum, and duodenum.

Hemorrhage from the duodenal ulcer should be treated as hemorrhage from the stomach. Stenosis may be relieved by a plastic operation or circumvented by gastro-enterostomy. If the stenosis is below the papilla and is of marked degree, treatment by gastro-enterostomy is unsatisfactory since the bile and pancreatic juice may have to flow through the stomach to reach the intestine. For the treatment of stenosis in the superior portion of the duodenum see page 423.

On account of the difficulty of diagnosis uncomplicated ulcer of the duodenum has seldom been treated surgically, yet it demands operative treatment more certainly than ulcer of the stomach, since duodenal ulcer rarely heals spontaneously, and is more likely to lead to serious complications than ulcer of the stomach. Relief, if diagnosis is made, will usually be obtained by gastro-enterostomy, or in certain favorable cases by a plastic operation upon the duodenum. Several cures following gastro-enterostomy have been reported by different operators. In a few instances gastro-enterostomy has been combined with suture of the pylorus so as to prevent the passage of any gastric contents into the duodenum.

The duodenum is usually reached through the free peritoneal cavity. If perforation of its posterior wall has set up a retroperitoneal suppuration, this may be reached by an incision through the right lumbar region, or through a lateral incision passing close behind the ascending colon.

ULCERS OF THE INTESTINE.

Ulcers of the intestine are of frequent occurrence and are due to a variety of causes. Most of them are superficial, heal spontaneously, and possess no surgical interest. Such ulcers may be catarrhal or

follicular or toxic (uræmic, mercurial). Other ulcers are more serious, but are spread over so large a portion of the intestine that they cannot be treated surgically (typhoid ulcers and disseminated tuberculous ulcers). In other cases the ulcers are merely a symptom or the result of a general condition such as amyloid disease, gout, syphilis, scurvy, or they are the result of an acute or chronic infection such as anthrax, sepsis, erysipelas, leprosy, dysentery, etc. These ulcers are not amenable to surgical treatment.

There are several kinds of ulcer for which surgical treatment must be considered. Duodenal ulcer has been spoken of. (See page 315.) Ulcers due to typhoid and ulcers due to tuberculosis, provided they are not disseminated, offer a fair field for surgical treatment. Operation may also be necessary for traumatic ulceration, for caustic ulcers, for ulcers due to foreign bodies, or twists, and finally for embolic or thrombotic ulcers. Carcinomatous ulcers are discussed in the chapter on New Growths of the Intestine.

Ulcer of the intestine never produces such typical symptoms as ulcer of the stomach. Indeed, it often exists without symptoms, and if it causes pain it is not of a typical character. There may be tenderness on pressure, and if the ulcer is accompanied by catarrh, diarrhœa. The stools may contain blood, pus, or fragments of tissue, which are, of course, significant; or they may contain the germs of tuberculosis or actinomycosis. The passage of mucus and membranes has little diagnostic value.

A surgeon is rarely called upon to treat an ulceration of the intestine until complications arise. These complications are: 1, perforation; 2, stenosis; 3, tumor; 4, diffuse or local peritonitis; 5, hemorrhage. Hemorrhage is most frequently seen in connection with typhoid ulcers and usually stops of itself. Moreover, the difficulty of locating the source of the hemorrhage would in most cases deter one from operating. So far as known, operation has never been undertaken for hemorrhage alone.

Perforation.—Any form of intestinal ulcer may lead to perforation, but this accident is much more likely to occur with some kinds of ulcer than with others. Perforation is not very uncommon in cases of intestinal tuberculosis, since it occurs, according to different observers, in from 5 to 10 per cent. of the cases. As in most of these cases the tuberculosis is disseminated and coexists with pulmonary tuberculosis, laparotomy is seldom indicated.

With typhoid perforation the case is different since typhoid fever is a disease which if uncomplicated usually terminates in recovery. Although the percentage of patients who suffer from fatal perforation is small—0.5 to 2.3 per cent.—this is still an important part of the fatality, which is generally estimated to range between 5 and 12 per cent. Finney's statistics, based upon the reports of 49 operated cases, show that perforation was in the ileum in 60 per cent., in the large intestine in 12 per cent., and in the appendix in 2 per cent. of the cases. Multiple perforations existed in 12 of the 49 cases. Pyæmic processes,

such as endocarditis, may lead to embolic and thrombotic perforation, although an ulcer of the wall of the intestine which ruptures into the lumen of the bowel is the usual outcome of this trouble.

Diagnosis.—The diagnosis and the results of intestinal perforation are discussed on pages 157 and 259. Perforation may lead to any one of the different forms of peritonitis—diffuse, gangrenous, suppurative, or encapsulated. If the ulcer has given no symptoms previous to perforation, the diagnosis may be very difficult.

Perforation occurring in typhoid fever is usually recognized. The sudden occurrence of collapse and intense pain, followed by the symptoms of peritoneal irritation, scarcely leaves one in doubt. Sometimes the temperature falls, sometimes it rises. There may or may not be a chill. Finney calls attention to the leucocyte count, which is from 3000 to 16,000 above normal. In some instances peritonitis occurring in typhoid is due to rupture of a suppurating mesenteric lymph-gland, or to rupture of a splenic infarct, while in 2 cases on record in which operation was performed symptoms of perforation were apparently due to fecal obstruction.

Treatment.—If the condition of the patient warrants it, typhoid perforation should be treated by operation. The indications and technic are given on page 262. Gesselewitsch and Wanach collected reports of 63 operations for typhoid perforation, with 11 recoveries. The most recent reports show a slightly better percentage. The sooner the operation is performed the better, of course, the chances of recovery. Diffuse peritonitis is not a counterindication.

A general anæsthetic should be avoided or given with the greatest care. A hypogastric median incision is the most serviceable. Perforation may be closed by simple suture or by excision and suture. Search should invariably be made for other perforations or ulcers which seem about to perforate. These suspicious places are more easily recognized at operation than at autopsy because of the circumscribed injection of the serosa. If there are several such perforations or suspicious ulcers close together, a portion of the intestine may be resected. This has been done with success in at least 4 cases. Drainage of the abdominal cavity is discussed on page 219. If the perforation cannot be found, a suspected portion of intestine should be tamponed, although all patients thus treated have died.

Whether perforation of a tuberculous intestinal ulcer shall be treated by laparotomy and suture depends upon the general condition of the patient, and also upon the extent of tuberculosis in other portions of the body. In the rare cases in which the disease is limited to the intestine the abdomen should be opened by a hypogastric incision and the perforation looked for in the lower portion of the ileum. If found, it should be treated as typhoid perforation. Tuberculosis which forms a tumor in the region of the ileocæcal valve rarely if ever leads to perforation into the free abdominal cavity. In any event, if the patient has extensive tuberculosis in other portions of his body operation for intestinal perforation is counterindicated.

Stenosis.—Any deep ulcer of the intestine in healing may produce stenosis, although different ulcers vary greatly in their tendency to do so. Thus stenosis rarely follows ulcers due to pressure or to typhoid, or to syphilis either congenital or acquired. It is also doubtful whether stenosis follows the healing of follicular and catarrhal ulcers. It was previously supposed that stricture frequently followed dysentery of the large intestine, but later observations have not sustained this theory.

Tuberculosis is the chief cause of stenosis due to ulceration not of a malignant character. This subject is considered below. Traumatism may produce stenosis as described on page 271. Such stenosis may follow necrosis of the intestinal wall without perforation into the free peritoneal cavity.

The intestine may become incarcerated in a hernial sac in such a way that a partial necrosis of its wall results which may lead to cicatricial stenosis. There are instances of strangulated hernia in which the gut is reduced by taxis or by an open operation. The necrosis may have extended to the serosa but not have involved it. Under such circumstances the necrotic portion of the intestinal wall will slough into the lumen and be replaced by fibrous tissue. Stenosis may be produced in another way. The incarcerated wall of the intestine sloughs and a fistula results. Such a fistula tends to spontaneous recovery, which may in turn be followed by contraction.

TUBERCULOSIS OF THE INTESTINE.

Tuberculosis of the intestine presents a variety of lesions which may be gathered into three groups:

1. The disseminated form without tendency to recovery.
2. Solitary or multiple ulcers with tendency to recovery.
3. Tuberculosis of the ileocæcal region with the formation of a distinct tumor.

Whether intestinal tuberculosis is ever a primary disease after infancy is an unsettled question. It is certain that in the great majority of cases it is secondary to pulmonary tuberculosis and is excited by tuberculous sputa which have been swallowed. Intestinal tuberculosis usually begins in the ileocæcal region, a portion of the bowel which seems to have less power of resistance than other portions, for typhoid ulcers and the lesions of actinomycosis and other diseases also develop here. This may be the result of stagnation in the fecal stream on account of the ileocæcal valve, or the angle at which the ileum joins the colon, or the presence of the vermiform appendix or the cæcum, or the great numbers of follicles which exist in the lower ileum, especially in young persons. The lymph-glands of this region are often found swollen and caseated in childhood, although there is no evident intestinal lesion.

When tuberculous ulcers begin to develop in the intestine of a patient suffering from pulmonary tuberculosis, they soon extend over

the greater portion of the surface of the intestine and exhibit little tendency to heal. This is, of course, true of ulcers which occur in any portion of the body of a marasmic individual, and besides there may be a specific condition of intoxication which prevents healing of these tuberculous ulcers. This disseminated form of tuberculosis of the intestine is the common form and it possesses no surgical interest. Eisenhardt, who made a thousand autopsies upon subjects dying from tuberculosis, found intestinal tuberculosis present in 563 cases, and in every one of these cases pulmonary tuberculosis also existed.

Tuberculous Ulcers which tend to Heal.—If the patient whose intestine contains a few tuberculous ulcers does not suffer from extensive tuberculosis of some other portion of the body, the ulcers of the intestine will show a tendency to heal. They may be situated in the ileocæcal region or scattered here and there throughout the intestine. The scar-tissue thus produced may or may not interfere with the fecal stream according to the situation and depth of the ulcer. The long diameter of a tuberculous ulcer is usually placed transversely, and the scar in contracting tends to narrow the lumen of the bowel. Stenosis may manifest itself before healing is complete, and it may be produced by local peritonitis set up by ulceration. According to Eisenhardt, symptoms of stricture occur in about 25 per cent. of the cases.

The stricture is usually situated in the ileum. The portion of bowel involved in the stricture may be very short or it may measure as much as 8 cm. (3.2 inches). Usually there is only a single stricture, although Hofmeister, who in 1896 collected reports of nearly 100 cases, found multiple strictures to exist in 21 of them.

Recently Reach collected 81 cases of multiple intestinal stricture exclusive of the rectum, and found the cause to be tuberculosis in 34 cases, carcinoma in 14 cases, syphilis in 12 cases, new growths not carcinoma in 2 cases, bands in 2 cases, dysentery and typhoid each in 1 case. Etiology was unknown in 15 cases. The seat of the stenosis was 48 times in the small intestine and for the most part in the ileum, 10 times in the large intestine, and 17 times in both the large and small intestine. Of the 48 stenoses of the small intestine, 21 were due to tuberculosis, 3 to carcinoma, 10 to syphilis, and 14 to unknown causes.

The intestine above the stenosis undergoes the changes spoken of on page 295. If there are multiple stenoses, the whole portion of the intestine which is involved becomes dilated and hypertrophied, so that several thick hard pouches result.

Symptoms.—The symptoms of tuberculous stricture are the usual symptoms of chronic intestinal stenosis; consequently the diagnosis of the tuberculous character of the stricture must be made indirectly. The history of the patient, his age, and the proof of other tuberculous lesions are most important. Most patients are between twenty and thirty years of age. Usually they are pale and look sickly. While

the existence of tuberculous lesions elsewhere confirms the diagnosis, their absence is no proof that intestinal tuberculosis does not exist.

Treatment.—The treatment of tuberculous stricture is an operative one. The symptoms of stenosis are to be relieved by resection or anastomosis. The indication for operation depends upon the tightness of the stricture, since a slight degree of stenosis may cause only slight or temporary symptoms. The choice of operation is spoken of in the latter portion of this section.

Ileocæcal Tuberculosis with Tumor.—The third form of tuberculosis of the intestine is associated with the development of a tumor, which is usually found in the ileocæcal region. This condition must be differentiated from chronic appendicitis and carcinoma, and not infrequently an operation is necessary before a positive diagnosis can be made.

This form of tuberculosis, like the other two forms already described, is usually secondary to tuberculous lesions elsewhere, and especially to slight tuberculosis of the lungs. The circumference of the portion of intestine affected may be normal, or increased, or diminished, but its lumen is invariably decreased on account of the thickening of the wall. This thickening is due to inflammatory processes which affect all the different layers. In this region this form of tuberculosis may be either subserous or submucous. That is to say, the lymph-glands in the ileocæcal region may be the seat of tuberculosis which extends to the serosa and thence into the subserous tissue of the intestine. The tubercles which are thus started show little tendency to break down, but they are accompanied with an inflammation which produces a great amount of connective tissue and later cicatricial contraction. The diseased intestine feels like a tumor to the palpating finger. As the muscular layers resist the progress of the disease, it tends to spread in the serosa and subserosa so that the tumor grows circularly and along the intestine.

The second form of the disease begins as tuberculosis of the mucous membrane. It shows little tendency to spread to other portions of the intestine, which may be due to a scanty supply of infectious material from the lungs. Extension outward is resisted by the muscular layer, so that most of the tubercles occur in the mucosa and submucosa. Sometimes the cæcum is more involved, sometimes the ileum.

Symptoms.—The patients who suffer from this form of tuberculosis are ill-nourished men and women between twenty and forty years of age. The symptoms are essentially those of chronic intestinal stenosis. Symptoms of ulcer and severe dyspepsia may or may not be present. There is never the uncontrollable diarrhœa of disseminated tuberculosis. The usual symptoms are alternating constipation and diarrhœa, with colic, rumbling, occasional vomiting, visible peristalsis, etc. The attacks of colic are the most prominent symptom. There is rarely complete obstruction. If there is persistent diarrhœa, it is probable that the ulcers involve a considerable portion of the intestine. Blood rarely appears in the stools and never in great quantity. Conrath

found it only 5 times in 85 cases. A tumor in the ileocæcal region is sooner or later observed by the patient or by the physician. Sometimes it is made more evident by distention of the colon with air. In other cases the disease progresses without symptoms until the tumor is discovered. This tumor is hard, nodular, and often visible through the abdominal wall. It is usually cylindrical, corresponding to the normal situation of the ascending colon, or, if the ileum is involved, it may be transverse. It is not very tender. It does not move with respiration, but can be shifted by the fingers, although they cannot reach around it. On percussion it yields a dull tympanitic note.

The mobility of the tumor gradually diminishes as the process extends. The lymph-glands, the mesentery, and mesocolon are gradually affected, the mass of the tumor increases in size and becomes adherent to the surrounding organs and to the anterior abdominal wall. Abscesses form within it which may perforate into the intestine, bladder, genitals, pleura, veins, or through the abdominal wall. Such perforation may take place, and a fecal fistula result without involvement of the peritoneal cavity.

Ileocæcal tuberculosis produces little or no fever except during the formation of an abscess. Fever may be the result of tuberculosis of other organs. The general condition of the patient depends chiefly upon the degree of stenosis.

This disease may persist for years. On the whole, the condition of the patient grows gradually worse, though it may remain about the same during long intervals.

The patient at last succumbs to the results of intestinal stenosis or to tuberculosis of the lungs, peritoneum, etc., unless a secondary inflammatory process, such as cellulitis or peritonitis, cuts his life short.

Treatment of Tuberculous Stenosis and Ileocæcal Tuberculosis.—The treatment of the second and third forms of tuberculosis of the intestine is best considered together since these two forms often coexist. As the diagnosis of tuberculosis can rarely be made with certainty, operation will usually be called for either on account of stenosis or on account of an ileocæcal tumor. The exact nature of the operation to be performed must be decided upon after the abdomen is opened. There are in general two possible methods of treatment: the removal of the diseased parts, or their elimination by an entero-anastomosis. The latter plan is technically simpler and less dangerous. By such an operation the patient will be relieved of his stenosis, and the diseased intestine, being free from constant contact with fecal matter, will be placed in a favorable condition for complete cure. On the other hand, radical operation will remove a large tuberculous focus and will exert a favorable influence upon the organism whether the tuberculosis is situated in the intestine or lymph-glands, or in some joint. The effect of such a radical operation upon a young patient is sometimes most striking. The weight increases rapidly and the color improves to a degree which can scarcely be explained by the simple relief of the stenosis. It can scarcely be doubted that toxins are resorbed from such a tuberculous

lesion, and that its presence in the body exposes the patient to a certain risk of infection.

In general, therefore, resection, if successful, yields better results than elimination, but the latter operation is less dangerous. If the condition is such that resection can be performed without technical difficulties and the patient's strength permits, it should be carried out. If the small intestine alone is involved, the stenosed portion should be resected. If there are several stenosed portions near one another, it is better to make a single resection of the whole. In such a case Köberle resected with success 205 cm. (82 inches) of small intestine. The ends of the small intestine should be united circularly by a Murphy button or by suture. If there is suspicion of stenosis lower down, the button should not be employed. If the cæcum and ileum are involved and the tuberculosis as yet is not too extensive, resection may be performed and followed by entero-anastomosis; or the anastomosis may be performed and the resection left for a later operation. If the portion of ileum which is involved is too extensive to warrant resection, the ileocæcal tumor may be removed and stenosis of the ileum higher up avoided by entero-anastomosis.

If the ileocæcal tumor is the only lesion, the surgeon may be in doubt as to whether it is tuberculous or carcinomatous. Under such circumstances extirpation is positively indicated. This had best be performed in two steps, as described on page 207. Extirpation of the cæcum is made easier by this method of procedure, since its elimination from the fecal current is usually followed by a marked decrease in the inflammatory swelling. Still, this method of operation requires that the anastomosed ends of intestine be dropped back into the peritoneal cavity. Mikulicz prefers the method of operating described on page 476, by which the involved portion of intestine is loosened and brought outside of the peritoneal cavity, and at a later date is excised extraperitoneally.

The results of operation are as follows: In 50 cases of total resection collected by Hofmeister there were 68 per cent. of cures, 2 per cent. of failures, and 30 per cent. of deaths. Thirteen patients were operated upon for simple stricture; 8 of these died and 3 recovered. Conrath mentions 48 cases of resection with immediate suture of intestine; 8 patients died and 1 lived with a fistula. Five times extirpation was followed by the establishment of a fecal fistula; 2 of these patients died.

Permanent results of operation are estimated with difficulty because of the late nature of the trouble. Conrath is able to make a report in regard to 30 of 47 patients who recovered from operation: 11 of them died after periods varying from one month to four years, 10 of them with pulmonary tuberculosis; in 1 case the cause of death was unknown. Two of the 19 patients living at the time of report showed symptoms of recurrence, 1 six months and 1 six years after operation; 1 suffered from pulmonary tuberculosis; 16 were apparently healthy at periods from one to seven years after operation.

Entero-anastomosis was performed in 10 cases with 10 recoveries,

1 of them being with a fecal fistula. One patient died some years later of pulmonary tuberculosis. The rest were alive at various periods up to four and a half years. In some cases the tumor had entirely disappeared. Incomplete elimination of intestine was performed in 1 case and complete elimination in 7 cases; 2 of these patients died.

ACTINOMYCOSIS OF INTESTINE.

The frequency with which the intestine is involved in human actinomycosis is shown by Illick's collection in 1892 of 421 cases: in 218 of these the disease involved the head and the neck, in 85 the abdomen, in 58 the lungs, in 11 the skin, and in 6 the tongue. The primary seat of the disease was not stated in 29 cases. Since that time Herz has collected 64 additional cases of primary actinomycosis of the abdomen. In cases of abdominal actinomycosis the fungus almost always enters the tissues through the alimentary canal, although in a few cases it has extended to the abdomen by continuity from the lungs or œsophagus. The patient swallows some article of food, especially some cereal, which contains the specific organism of the disease. Such particles of food lodging in the intestine, and usually in the appendix vermiformis, are the starting-point of the trouble. In other instances the disease has been traced to ingestion of imperfectly cooked flesh of some animal suffering from actinomycosis. In rare cases actinomycosis of the mouth is transplanted to the lower portion of the alimentary canal. The persons affected by actinomycosis are for the most part country residents of the male sex, between the twentieth and fortieth year of life.

The contents of the stomach and small intestine seem not to be favorable to the development of actinomycosis. At any rate, it usually develops in the lower portion of the alimentary canal. At the time of operation or autopsy the lesions are found so widespread that it is impossible to state just where the disease began. Grill collected reports of 111 cases of abdominal tuberculosis in which the patients were treated surgically. The starting-point of the disease was said to be in the stomach once, in the small intestine 6 times, in the cæcum and vermiform appendix 16 times, in the colon 8 times, and in the rectum 7 times. The probable origin of the disease was given in 57 additional cases as 44 times in the cæcum and 13 times in the rectum. The fungus rarely develops in the mucous membrane, but passes this and spreads in the submucosa, where it forms flat whitish rows or nodules which often lead to ulcers. Ultimately the process spreads to the serosa. In other cases the organisms penetrate the whole thickness of the abdominal wall and develop in the peritoneal cavity.

Actinomycosis of the intestine is a chronic inflammatory process which is associated with an abundant production of new tissue, and also with active tissue-destruction. Sometimes the process comes to a standstill or is completely recovered from; at other times it continues actively. The actinomycosis in other organs, for example, the tongue

or skin, often exists for a long time as a non-inflammatory tumor. This is rarely the case with intestinal actinomycosis because mixed infection soon occurs. When parasites reach the peritoneal cavity, they spread rapidly in the serous and subserous tissue setting up adhesions everywhere. Sometimes they penetrate the posterior abdominal wall and sometimes the anterior abdominal wall with the formation of numerous fistulas. The disease is not at all limited by the anatomical structure of the tissues. It penetrates without difficulty fasciæ, muscles, and even bones, and therefore runs an extremely aggressive course in counterdistinction to tuberculosis.

The color of the granulations is in many cases characteristic of actinomycosis. They have frequently a peculiarly active bright-red appearance and bleed at the slightest touch. The purulent discharge is usually thin, less often stringy, and frequently contains the characteristic granules. The parasites of actinomycosis may spread throughout the body not only by continuity, but also through the bloodvessels. They do not seem to enter the lymphatic channels, and swelling of the lymph-glands is to be set down to a mucous infection.

Symptoms.—The clinical course of abdominal actinomycosis is distinctly chronic like that of actinomycosis in other portions of the body, although on account of mixed infection it may take on a more acute character. Grill divides the disease into three periods: the initial period, which is usually latent, the period of tumor-formation, and the period of suppuration and fistulas. The first symptoms of the disease are rather indefinite, such as intestinal catarrh, more or less acute or chronic at intervals. These symptoms may last for some weeks or months before a tumor appears. Sometimes catarrh is wanting and tumor is the first symptom noted. The tumor, as stated above, is usually in the ileocæcal region. It varies in size and in the freedom with which it can be moved. It is usually attached to the abdominal wall, or it may infiltrate the wall. In the latter case it feels very hard and is poorly marked off from the surrounding tissue. There is little pain and little tenderness on palpation, although exceptions to this are mentioned. At this stage of the disease the trouble may be mistaken for chronic appendicitis, or an abscess or sarcoma of the abdominal wall. In some cases the adhesions due to abscesses are wanting and the tumor maintains its mobility until it reaches a large size. When the abdominal wall is involved, fluctuation can sooner or later be made out; and if the mass is not incised, one or more fistulas develop spontaneously. These are usually in the ileocæcal or right inguinal region.

The pus which is discharged has the characters above described. Sometimes it is mixed with feces. Sometimes one may seek in vain for the parasites in the pus. Under such circumstances bits of granulation-tissue should be examined, as they usually contain the parasites. Culture of these parasites is unsatisfactory since the culture preparations are soon overgrown by bacteria.

Actinomycosis, even when it forms a distinct tumor, rarely produces symptoms of intestinal stenosis. The general health of the

patient is none the less affected. There is more or less fever which is of no regular type, and if high is probably due to mucous infection. The nutrition of the patient suffers, not so much on account of the primary lesion as on account of the chronic suppuration. A marked degree of marasmus follows, and finally amyloid degeneration. Sometimes the percentage of hæmoglobin is very low.

One of the most serious complications which befall a patient with actinomycosis is a fecal fistula. This is, however, relatively rare, on account of the tendency to adhesions and the complicated course of the fistula. For the same reason diffuse peritonitis is not a common accident, and the abscesses break usually not into the free peritoneal cavity, but into the bladder or kidneys or pleura. The liver is a common seat of metastasis. General miliary infection of the body is rare.

Diagnosis.—The diagnosis of actinomycosis of the intestine, and especially of the ileocæcal region, cannot be made with certainty until the disease breaks through the skin or some of the characteristic fluid is obtained for examination. It may be suggested by the chronic course, the ill-defined infiltrating tumor with areas of softening. If the tumor is well defined, and has no areas of softening, and there is no infiltration of the abdominal wall, a differential diagnosis between this and other intestinal tumors cannot be made. If the actinomycosis is situated in the region of the cæcum, it must be differentiated from carcinoma, from tuberculosis, from chronic appendicitis, or, if the abdominal wall is involved, from abscess and tumor of the abdominal wall. (See the description of actinomycosis of the abdominal wall given on page 132.) If there is a retroperitoneal tumor, it must be differentiated from lesions of the kidney, of the vertebral column, of the ileum, and of the retroperitoneal glands. If there are fistulas with diffuse infiltration, one has to differentiate actinomycosis from tuberculous fistula starting from the intestine or peritoneum or bones, and from syphilitic processes.

Prognosis.—The prognosis of abdominal actinomycosis if left to itself is bad. Spontaneous cure has never been observed. Internal treatment by potassium iodide is equally unsatisfactory. Sooner or later the patient dies from marasmus or some complication of the disease, although he may live for two years or longer.

Treatment.—The treatment is purely surgical. The character of the operation must depend upon the extent of the process and the general condition of the patient. Even though the patient is strong, it will rarely be possible to resect the whole of the affected intestine.

The simplest surgical treatment is the opening of the various abscesses. This has the effect of allowing the escape of pus, and the presence of air seems to limit the growth of the parasite, which is an anaërobic bacterium. For this reason the various fistulas should be split up as far as the function of the parts involved will permit. If there are intraperitoneal abscesses, they may be shut off from the peritoneal cavity to be opened at a later date. Partial excision and curetting may also be employed. In every case of actinomycosis whether

an operation is performed or not, the patient should be given potassium iodide to the extent of 3 to 5 grammes (45 to 75 grains) daily. Numerous experiments upon animals and observations upon men have shown that potassium iodide is not a specific against actinomycosis; and further, that it has no influence either upon the growth of the parasite or its virulence. Its favorable action is exerted upon the diseased tissue. It favors softening of the affected tissue, limits extension of the process, and facilitates external rupture of abscesses. Naturally it increases the resorption of inflammatory products. The parasites are thus deprived of their means of subsistence and die, and are either resorbed or discharged through the fistula in the case of abdominal actinomycosis. The administration of potassium iodide is often followed by pain, tenderness on pressure, and fever.

While treatment by potassium iodide is not of itself sufficient to cure a patient suffering from abdominal actinomycosis, it is a distinct aid to surgical treatment in that it exerts a favorable influence upon portions of the disease not accessible to the surgeon's knife. It is in other cases an excellent preparatory treatment for operation.

This action of potassium iodide is not sufficiently specific to serve as a means of diagnosis, although it is very suggestive in cases in which there is no suspicion of syphilis.

Treatment by iodide and by operation combined has saved a considerable number of patients. Thus, in Grill's collection of 111 patients who were treated by operation, 45 died, 22 recovered, 10 were improved, and the remainder were either under treatment at the time of report or had been lost sight of. Some patients were cured in whom the disease had existed as long as two years.

EMBOLISM AND THROMBOSIS OF THE MESENTERIC VESSELS.

Injuries of the mesentery are spoken of on page 272, and tumors on page 386. The only other processes of surgical interest are disturbances of the circulation due to embolism or thrombosis and contraction the result of mesenteric peritonitis. The latter occurs usually in the mesosigmoid. The mesentery may be the seat of adhesions due to peritonitis and which may interfere with peristaltic motion. The circulatory disturbances of the mesentery produce symptoms which are so like those of intestinal lesions that an error in diagnosis is easily made.

The blood circulation in the intestine is abundant, and in the mesentery the vessels anastomose in three lines of arches; therefore embolism or thrombosis of the branches of the mesenteric arteries does not usually interfere with the intestinal circulation. If the superior mesenteric artery itself is obstructed, the blood-supply of the intestine can be maintained only through the gastroduodenal artery on one side and the inferior mesenteric artery on the other side. If the inferior mesenteric artery is included, the blood-supply can be kept up by the superior mesenteric and the middle and inferior hemorrhoidal arteries.

The obstruction of the superior mesenteric seriously threatens the life of the intestine. This is not to be wondered at when one considers that the blood to reach the intestine through the anastomosing channels must pass for two or three feet through a relatively narrow network of vessels. Experience has shown that the stoppage of the superior mesenteric produces a hemorrhagic infarct in a considerable portion of the small intestine. Even embolism of certain branches of the artery may produce a hemorrhagic infarct. If the circulation of blood can be restored through the anastomosis, the infarcts will gradually disappear, otherwise there will be necrosis of intestine with its natural consequences. The latter is almost always the case when the trunk of the superior mesenteric artery is occluded. It does not so readily follow occlusion of the inferior mesenteric. Even a small infarct may terminate in perforation, while in other cases a much larger infarct may be followed by recovery. In rare cases obstruction of the arterial vessel is not followed by venous congestion, and in such circumstances an anæmic infarct and gangrene will be the result.

Embolism may be due to septic processes, to endocarditis, to arteriosclerosis of the cardiac valves, aorta, etc. Thrombosis may be due to local arteriosclerosis, syphilis, traumatism, rupture of an artery, hæmatoma, or injury of a vessel during operation.

Embolism of the mesenteric arteries produces usually an intense colicky pain. This may be followed by hemorrhage and diarrhœa, or by ileus. The blood oozes from the mucous membrane which is involved in the infarct and becomes mixed with the intestinal contents. This hemorrhage may be so profuse as to cause death from anæmia. If the infarct is situated high up, the blood may be vomited. In a small majority of cases the disturbance of nutrition of the intestinal wall brings about paralysis and rapidly developing ileus. Even the swollen infarct which extends throughout the whole circumference of the bowel may set up paralytic ileus. In such cases there is no discharge of blood from the rectum, but instead there are the usual complete obstruction and other symptoms of ileus. The vomiting may be bloody in character. No good explanation of this has been given. Sprengel suggested that hemorrhagic infarct was followed by intestinal hemorrhage, and anæmic infarct by ileus without hemorrhage. It is, however, certain that ileus may be produced by a hemorrhagic infarct, and the ultimate outcome of both types of the disease is the same.

If the resection is re-established, the patient recovers, otherwise necrosis of the intestine and peritonitis, either before or after perforation, are the inevitable results.

The prognosis of embolism of the mesenteric arteries is unfavorable. However, it is but right to give the patient the benefit of operation, especially as in most cases ileus from other causes cannot be excluded. The surgical treatment of these cases is difficult. In the first place, the diagnosis is uncertain. If there is profuse intestinal hemorrhage with diarrhœa under circumstances which make the development of embolism or thrombi possible, a probable diagnosis can at

least be made. If no previous history of trouble can be obtained, or if there is ileus without hemorrhage, a correct diagnosis is unlikely to be made. Even when one hits upon the correct diagnosis, it is impossible to say whether spontaneous recovery will follow. On the other hand, if one waits until necrosis and possible perforation have developed, the patient's chances for recovery are greatly reduced.

Nor is it possible to say how extensive an infarct there may be. The only hope of the patient lies in resection of the affected bowel, and until the abdomen is opened one cannot know whether resection is possible. If the whole small intestine is involved, radical operation is naturally useless. When the abdomen has been opened, the surgeon will still have to decide whether he will remove all of the bowel which is infarcted, or only such portions as seem likely to become gangrenous. If the patient's condition forbids an extensive operation and the portion of intestine which is affected is situated low down, the establishment of an artificial anus above it may be advisable. Thus far the results of operation have been discouraging, as few patients have recovered.

Obstruction of the mesenteric veins has the same significance as obstruction of the arteries. Such obstruction is almost invariably due to thrombosis, as embolism can then only occur by reason of a reversed blood-current. Only a few cases have been noted, most of them due to enteritis occurring in patients who suffered from sclerosis of the liver. The first result of a complete venous stasis is œdema of the affected portion of the bowel followed by an arterial infarct whose anatomical and clinical consequences are those which have been described above, namely, hemorrhage, diarrhœa, or ileus. The result is usually necrosis of the mucous membrane, less often gangrene of the whole wall of the intestine.

If the portal vein becomes occluded by a thrombosis, the stomach, intestine, etc., will be the seat of an infarct, and to the symptoms thereby caused will be added ascites, compensatory dilatation of the anastomosing veins (*Caput Medusæ*), splenic tumor, and necrosis of the pancreas.

CHAPTER XVI.

INTESTINAL OBSTRUCTION, OR ILEUS.

By Prof. H. SCHLANGE.

The term ileus is used not to indicate a special pathological condition, but a group of symptoms among which four are especially prominent: namely, stoppage of the fecal stream, abdominal pain, vomiting of material which contains bile and feces, and meteorism. The existence of ileus is always serious, since it indicates the presence of an obstruction to the fecal stream which may quickly terminate the patient's life.

Pathology.—Ileus is called dynamic when it results from failure of peristaltic action, and mechanical when it is due to some closure of the intestinal lumen.

Dynamic Ileus.—In this variety of ileus there is paralysis of the longer or shorter portion of the intestine. Not every apparent or real paralysis of the abdominal muscles leads to ileus. The effect may be transitory. Such reflex paralysis may be observed after incarceration of a testicle in the inguinal canal, contusion of the abdomen, operation upon hemorrhoids, etc. There is also a hysterical intestinal paralysis which need not be here considered. True dynamic ileus may be brought about by extensive operations upon the mesentery, by the reposition of large strangulated hernias, or by embolism of the mesenteric arteries. In some diseases of the central nerves defecation is so impaired that large masses of feces collect in the colon and bring about dilatation and paralysis which may lead to ileus. Nothnagel says that distention of the intestine with gas may produce paralysis, and it seems probable that in some instances paralysis is due to the action of bacteria, although no evidences of peritonitis are present. But the most important cause of all is acute peritonitis. Chronic peritonitis causes trouble less by paralysis of the intestine than by the kinks and narrowings which are due to adhesions, or by the pressure of exudates outside of the intestine.

Just why inflammation of the peritoneum should cause paralysis of the intestine is still a matter of dispute. Stokes claims that the inflammation of the serosa extends to the deeper layers of the intestinal wall, and that the paralysis is due to the œdema which accompanies it. Nothnagel explains the paralysis by reflex action. He shows that in the beginning of subacute peritonitis peristaltic action may be abnormally increased. The absorption of gas from the intestine is lessened or stopped by the peritonitis, and in consequence the

intestine becomes overdistended and paralysis may follow. Ileus may follow circumscribed as well as diffuse peritonitis. Sometimes the circumscribed peritonitis affects only the portion of the intestine in its immediate neighborhood.

Mechanical Ileus.—In mechanical ileus the lumen of the bowel may be closed by pressure from without, or by some obstacle within it. In the former case the term strangulation is often used, and in the latter case obstruction. Strangulation of the intestine is a condition

Fig. 82.

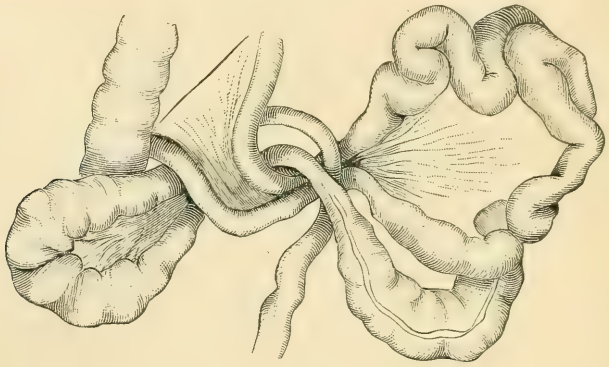
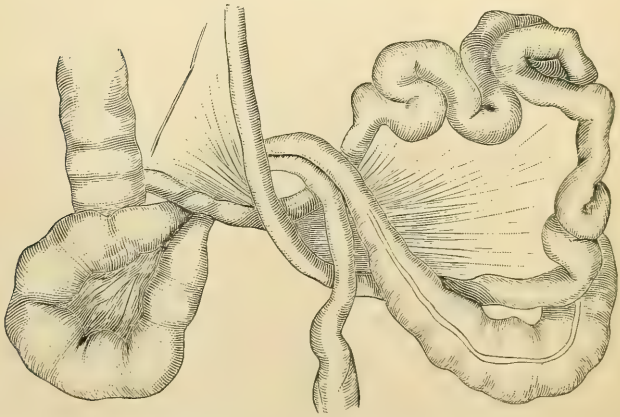


Fig. 83.

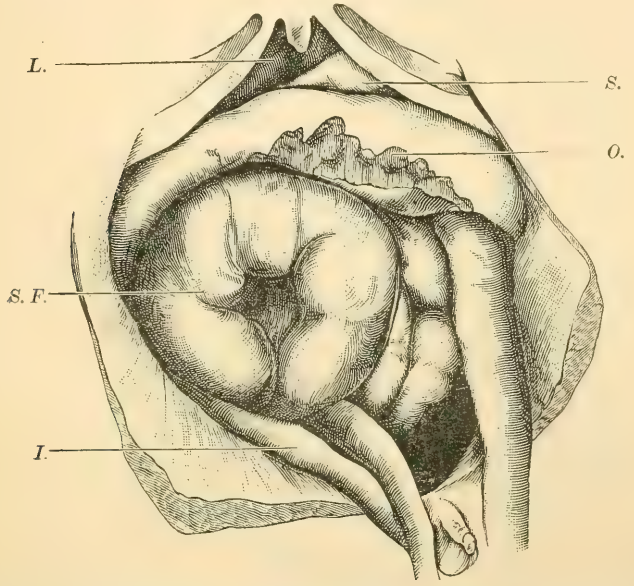


Figs. 82, 83.—Two forms of obstruction due to a combined volvulus of a coil of ileum and a long sigmoid flexure. (Küttner.)

in which the affected portion of intestine, together with its mesentery, is so pressed upon that not only is the lumen of the intestine obliterated, but the circulation is also interfered with to a dangerous extent. This condition is clearly seen in strangulated intestinal hernia. Strangulation may be due to bands or cords, the result of peritoneal adhesions which may be found in any portion of the abdominal cavity, and are of variable size and thickness. Portions of intestine may be

changed by peritonitis until they become like cords and may lead to strangulation. The tip of the appendix or of the Fallopian tube, or of Meckel's diverticulum, may also produce strangulation. A rent in the broad peritoneal adhesions, or a gap in the omentum or mesentery due to faulty development or traumatism, may produce intestinal strangulation. The same is true of a rent in the uterus, or bladder, or suspensory ligament of the liver, or the broad ligament of the uterus, or the parietal peritoneum. An external hernia may become strangulated. The situation of such hernias is sufficiently indicated by the

FIG. 84.



Volvulus of sigmoid flexure after its passage through an opening in the mesentery: *L.*, liver; *S.*, stomach; *O.*, omentum; *S. F.*, sigmoid flexure; *I.*, small intestine. (Gruber.)

names—obturator, ischiatic, perineal, lumbar, rectal, vaginal, intercostal, diaphragmatic. An internal hernia may also become strangulated in the foramen of Winslow in the intersigmoid space, in the peritoneal pockets about the cæcum, or in those about the duodenum and jejunum. The results of such internal strangulation are similar to those of external strangulation. In strangulation by a band a short portion of intestine is usually caught between the band and the posterior abdominal wall. The ileum is usually the portion of intestine that is strangulated in both external and internal hernias. On account of its long mesentery this portion of intestine may find its way to any part of the abdominal cavity.

Strangulation due to twist of an affected bowel upon its axis is called volvulus. According to Rokitansky, this twist may take place in three ways:

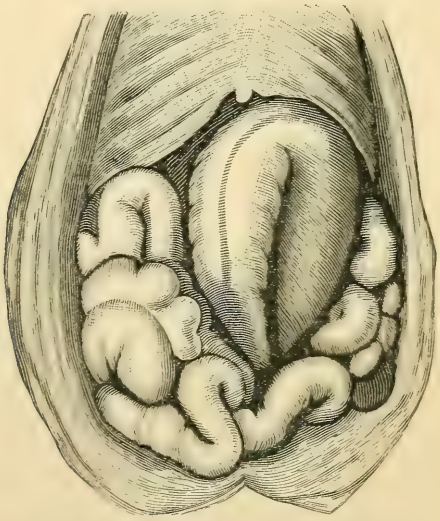
1. The portion of intestine may twist through a half circle or a whole circle around its own long axis.

2. The mesentery or a portion of it may twist with the attached intestine through a half circle or whole circle, or more than a circle. This twist is therefore around the axis of the mesentery.

3. A portion of intestine together with its mesentery may twist around another loop of intestine. (Figs. 82 and 83.)

The sigmoid flexure is by far the most frequent seat of volvulus. In its typical form the flexure has a long mesocolon with a short attachment to the posterior wall of the abdomen, so that it is easy for it to twist about the axis of the mesentery. This twist may result from external violence, as a fall or jar, or it may be due to overdistention

FIG. 85.



Volvulus of the sigmoid flexure. (Curschmann.)

of the bowel with fecal masses. v. Samson has shown that a twist of 180 degrees will not produce strangulation in a normal sigmoid flexure. Symptoms first arise when the twist has reached 270 or 360 degrees. (Figs. 84 and 85.)

Volvulus of other portions of the colon is not likely to occur unless the mesocolon is abnormally long. Volvulus of the small intestine may occur when the whole portion of small intestine which in any way becomes strangulated in addition twists around its mesenteric pedicle. An abnormal length of mesentery, or a shortening of its attachment to the posterior abdominal wall, predisposes to volvulus of the small intestine. Such a condition may be congenital or may be the result of peritonitis, or the fixation of a loop of intestine for a long time in a hernial sac.

Ileus may be produced by obstruction of the lumen of the intestine either from within or by a slowly developing pressure from without.

Foreign bodies, biliary calculi, intestinal calculi, and fecal masses may produce obstruction. (Fig. 88.) Usually the obstructing object is as large or larger than a walnut, but instances have been reported in which a small stone by producing local contraction of the muscles has obstructed the lumen of the bowel. Obstruction of this character may occur in any portion of the small intestine, especially at the ileocæcal valve. True intestinal calculi or enteroliths form gradually in the large intestine, and especially in the cæcum. The nucleus of such a calculus may be some small indigestible object which has been swallowed, and the bulk of the calculus is made up of calcium, ammonio-magnesium phosphate, and organic substances. In cases of habitual constipation with atony of the intestine hard masses of feces may collect in the large intestine until they completely block its lumen. Overloading of an intestinal coil wherever found may predispose to a kink or a volvulus. Furthermore, chronic distention often leads to dynamic ileus.

The lumen of the bowel frequently becomes obstructed by intestinal carcinoma. The growth is usually situated in the colon or rectum. Sarcoma and lymphosarcoma rarely reduce the lumen of the bowel sufficiently to produce obstruction.

Other diseases may bring about chronic ulceration and stricture; for example, tuberculosis either in the small or large intestine, or, less often, dysentery, or the ulcers due to fecal masses. Syphilis is frequently the cause of stricture in the rectum. Stricture may develop in a loop of intestine which has been incarcerated in a hernial sac, perhaps as a result of circular gangrene of the mucous membrane. Any intussusception may go on to spontaneous cure after the invaginated bowel has sloughed away, but stricture is likely to result.

Tumors in the neighborhood of the intestine, and especially those of the uterus and ovary, may compress the intestine and obstruct its lumen.

Invagination (intussusception) of the intestine sometimes produces symptoms of obstruction, sometimes of strangulation. Invagination is a displacement of a portion of intestine by which the upper part of the bowel is invaginated into the lower. In a few instances the relation of the affected parts of the intestine is reversed and the upper part is carried downward outside of the lower part. The commonest seat of this trouble is the ileocæcal region, since here occur 52 per cent. of all cases and 70 per cent. of the cases which occur in infancy. Invaginations of the small intestine constitute 30 per cent. of all cases and those of the colon 18 per cent. In ileocæcal invagination the ileocæcal valve marks the summit of the displacement, while the invaginated small intestine may extend for a great distance into the colon, and has even protruded through the sphincter ani. In other invaginations of the small intestine the lower portion is usually involved, while invagination of the sigmoid flexure is more common than that of other portions of the colon.

The invaginated bowel drags after it the mesentery, consequently the mesenteric side of the invagination is somewhat concave and the

whole swelling is kept nearer the vertebral column than would otherwise be the case. The longer the invagination, the more marked are these characteristics. If the pressure upon the invaginated bowel and its mesentery is slight, they become first hyperæmic and then œdematous, especially at the summit of the invaginated portion. If the stricture continues, hemorrhages take place into the tissue and into the lumen of the bowel. In chronic cases the swelling gradually disappears and the permeability of the intestine is to a certain extent restored. If the case is an acute one and more severe, the arterial and venous circulation are entirely shut off and gangrene results. The invaginated portion is naturally the first to suffer from the gangrene. It may be separated from the rest of the intestine and be passed from the rectum in pieces measuring from a few centimetres to 3 metres (120 inches). Such a discharge of gangrenous bowel will usually take place during the first month, but in some cases it has occurred six months or even longer after the first symptoms of intussusception.

The immediate danger of invagination lies in the risk of perforation of the neck of the bowel and resulting peritonitis. In the chronic form of the trouble there is risk of death from inanition, and even in the fortunate cases in which the invaginated bowel sloughs away life may be threatened by a resulting stricture.

Symptoms.—The general symptoms of ileus are obstipation, abdominal pain, meteorism, and vomiting. Obstipation needs no explanation. The pain is due to irritation of the peritoneal nerves, and the meteorism is due to the development of gases in the stagnant contents of the intestine. Mere stagnation of the fecal stream is not sufficient to explain this formation of gas. It is a pathological symptom due to degenerative changes in the intestinal contents, and also due to the decreased absorption of gas by the intestinal wall. To explain the fecal vomiting, it is not necessary to suppose that reversed peristaltic movement takes place. When the stomach has been emptied by violent vomiting, it is easy for the contents of the small intestine to overflow into it. These contents have a foul and often fecal odor, and in some instances have been said to contain formed fecal masses. These were probably, however, milk coagula or other portions of food which were stained with bile. From the character of the vomitus it is absolutely impossible to determine the situation of the obstruction in the intestine. Attention has been called to the increased amount of indican in the urine during ileus. This is due to the absorption of putrefactive albuminous matter from the small intestine. It can be found as early as the second day in case the small intestine is the seat of obstruction, but it does not occur, or at any rate not for several days, if the obstruction affects only the large intestine. It also occurs with a variety of other diseases which bring about putrefactive changes of the contents of the small intestine, so that while it is not a symptom without value, too much stress must not be laid upon it.

Diagnosis.—In most cases of ileus the diagnosis is apparent. The difficulty consists in the determination of the site and cause of the

PLATE V.

Ulceration and Perforation of the Ileum, eight days after Complete Obstruction. The necrotic mucous membrane was somewhat greener when first exposed.

ileus; but in the majority of cases it is unnecessary to do more than to determine whether the ileus is dynamic or due to strangulation or obstruction. In certain cases naturally one or more of these causes may act in combination.

The first step is a careful examination of the patient. While the attention is especially directed toward the intestine, the other organs both within and outside of the abdomen should also be examined. The demonstrable changes in the intestine are modifications in its form and in its mobility. Numerous observations as well as experiments upon animals have established the following facts:

1. In acute peritonitis the wall of the affected intestine is paralyzed. This portion of intestine becomes distended with gas and its mobility is limited.

In acute circumscribed peritonitis the paralysis and dilatation do not reach their maximum so that slight peristaltic motion may be observed in the affected intestinal coils. Acute diffuse peritonitis when of a severe type produces a dilatation of the intestine which is only limited by the space within the abdominal cavity. The paralysis is complete and there is no motion whatever.

2. When a coil of intestine with its mesentery is strangulated, there follows an acute swelling of the affected portion, as is regularly seen in operations upon strangulated hernias. The distention of the strangulated intestine, if it occurs in the general peritoneal cavity, is extreme, far greater than is possible in a closed hernial sac. As the loop of intestine is mechanically fixed at a point of constriction, it cannot move and all peristaltic motion is stopped by the alterations in the circulation and innervation. This is true even if the affected intestine is a metre in length. There is a discharge of fluid from the strangulated intestine which is often seen in a hernial sac, and the quantity of which within twelve hours may be so considerable that it is noticeable in the peritoneal cavity.

The condition of the rest of the intestine is likewise characteristic. The bowel below the affected portion is empty and contracted, and remains so. The bowel above the affected portion is more or less distended according to the time of observation. In general, it is true that it gradually fills with fluid and becomes distended with gas. The greater the portion which is strangulated and the more perfect the strangulation and the greater the shock, the greater the delay in the distention of the bowel above. In such circumstances the distention may be only moderate after a period of twenty-four hours. In these severe cases death results early unless it is averted by an early operation, so that one will rarely see an extreme distention of the afferent bowel.

If only a small loop is strangulated and the strangulation is perhaps incomplete, the intestine above the strangulation becomes sooner or later greatly dilated. In these milder cases life may be prolonged for several days. The upper intestine is not at first completely paralyzed, but shows peristaltic motions and slight tonic contractions which may come on spontaneously or as a result of external irritation Gradually the

efferent intestine becomes distended, and this distention is almost always palpable before it becomes visible to the eye. It is always a suspicious symptom when one is able to feel the outlines of individual portions of the intestine.

If the strangulation leads to peritonitis, a resulting paralysis of the intestine does away with intestinal motions and gradually obscures the contour of single dilated intestinal coils.

3. In obstruction of the intestine the portion of bowel below the obstruction is empty and collapsed, while that above the obstruction is very full. This distention decreases from the point of obstruction toward the stomach. As long as there is no peritonitis, peristaltic action continues in the distended intestine, but is of varying intensity. If the obstruction is superimposed upon an existing stenosis due to a tumor or gradually narrowing stricture, etc., the muscular coat of the bowel above will have become hypertrophic. Therefore in such a case the peristaltic action following obstruction will be exaggerated. (See page 295.

Diagnosis and Treatment of Dynamic Ileus.—Whenever a patient is seen who is suffering from ileus the surgeon should put to himself the question: Is peritonitis present? In most cases the answer to this question will not be difficult. If the abdomen is everywhere sensitive; if there is absolute constipation and continuous vomiting of a biliary or fecal character; if a patient is restless and has an anxious, drawn countenance and hollow, lifeless eyes; if the respiration is of a costal type and somewhat rapid, and there are a moderate elevation of temperature and a small, easily compressible and frequent pulse; if there are great thirst and decreased excretion of urine; if there is a uniformly distended barrel-shaped abdomen without visible or palpable intestinal coils, and if no peristaltic action can be heard, the picture of diffuse peritonitis is typical. The absence of distinct coils of intestine is a most significant sign. It indicates an extensive intestinal paralysis such as accompanies acute diffuse peritonitis. There are other symptoms that are by themselves less reliable. The temperature is uncertain. In most cases of acute peritonitis there is moderate and sometimes high fever. There are also cases in which the temperature is normal or even subnormal. While therefore in doubtful cases the presence of fever is suggestive of peritonitis, its absence is no proof that peritonitis does not exist.

The next question of importance is, What is the origin of the peritonitis? This cannot be determined by direct examination in most cases because the meteorism makes impossible palpation of the abdominal organs. The history of the disease may, however, throw light upon the origin of the inflammation. It may indicate the existence of appendicitis, or it may show that an ulcer of the stomach or intestine existed for a long time before the acute attack (due apparently to perforation) came on. If no such evidence is furnished by the history, one has to think of mechanical obstruction or strangulation of the bowel.

The better developed the peritonitis, the less is the chance of saving the patient by surgical interference; and if the patient is already septic with greatly decreased arterial pressure, it is better to look upon the case as hopeless, and not to subject the patient to a surgical operation. This is more fully discussed on page 174.

If the peritonitis follows a mechanical ileus and the patient is seen sufficiently early, the treatment should be that which is proper for a patient suffering from ileus in spite of the unpleasant complication of peritonitis.

Slight and circumscribed inflammations of the peritoneum may produce the symptoms of ileus, at least for a time. In such cases the diagnosis is suggested by the occurrence of the trouble in the neighborhood of the organ which is often the starting-point of circumscribed peritonitis; for example, the appendix, the gall-bladder, or a tube or ovary. The severe symptoms of collapse which accompany diffuse peritonitis and strangulation of the intestine will be wanting. The loops of intestine which are involved are plainly distended and usually movable. Pressure upon them does not increase their tension since their contents can easily escape, usually with a gurgle, into the adjacent portion of intestine. Absolute rest, a suitable diet, and opium suffice in many of these cases to bring the patient again to a condition of health, provided the cause of the trouble does not extend further.

The symptoms of ileus may accompany hysteria, fecal impaction, diseases of the spinal cord, etc. The diagnosis may be a difficult one. Treatment of these cases is described in books on internal medicine.

Diagnosis of Ileus due to Strangulation.—If existing ileus can be shown to be mechanical rather than dynamic, it is important to determine whether it is due to strangulation, since strangulation of a loop of intestine may produce gangrene in twenty-four hours. In some cases it does not act so quickly because the strangulation is not complete, or is intermittent, so that it obstructs the lumen of the bowel but does not shut off its blood-supply, and gangrene does not follow even after a lapse of weeks. In such cases the original hyperæmia and swelling of the intestine may subside, but traces of the trouble will persist in the form of adhesions between the affected intestine and the surrounding organs.

Cases of strangulation vary greatly in severity, and no one can say what the outcome of even a slight attack will be. The danger to the patient is not merely in possible gangrene, but rather in the peritonitis which results from the passage of bacteria through the damaged wall of the intestine before it actually becomes gangrenous. Experiments upon animals show that this bacterial exodus may occur within eight hours. The time depends largely upon the degree of strangulation. It is partly on this account that operations performed in the first or second day after attack show far better results than those performed upon the third day or still later. This point should be impressed upon the minds of family physicians, who first see the majority of these patients. If the diagnosis of strangulation can be made and an oper-

ation performed within forty-eight hours, the risk of gangrene and infection is pretty nearly avoided. If three days have passed without relief, the patient is almost certain to die from one or other of these causes.

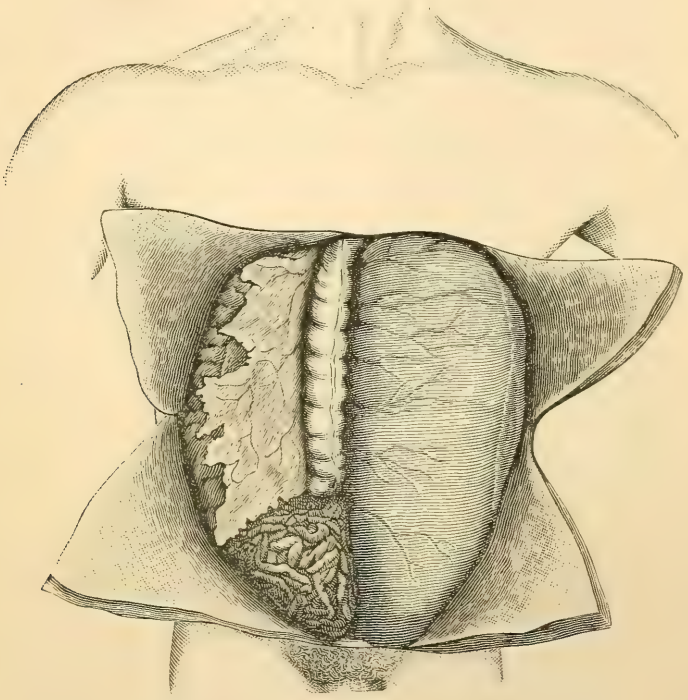
The mechanism of strangulation is so uniform that the symptoms in most cases are fairly typical. A patient in full health is suddenly seized with a more or less intense pain and feels that he is very sick. There are often symptoms of shock, which may increase during the following day or days. Such collapse is said by Bönnecken and Riechel to be due to the escape of bacteria and other products into the peritoneal cavity. These substances when resorbed produce the symptoms of collapse. Soon after the strangulation the symptoms of ileus appear. There are nausea and vomiting, first of gastric contents and then of biliary and finally of fecal fluid. Rectal tenesmus may be an early symptom. If feces are present in the lower bowel, they may be expelled, but later neither gas nor feces pass per anum. Soon the outline of the abdomen begins to change, and its shape should be carefully noted. Aimless palpation of the abdomen causes the patient great pain and yields comparatively little information; and even the most intelligent examination is unsatisfactory if the abdominal walls are extremely thick or if the abdominal muscles are firmly contracted. In the more favorable cases in which the abdominal wall is relatively thin the affected loop of intestine, whether strangulated by a band or by a twist around its own axis, will be found greatly dilated and marked off from the rest of the coils of intestine which are displaced by it. Sometimes the distended intestine may be recognized by the eye as a thick transverse cylinder, or its outline may be curved or bent upon itself. As the intestinal wall is paralyzed, it does not show the slightest motion even when struck. If no such appearance is evident to the eye, the open hand should be lightly passed over the abdomen and then gentle pressure be made in perpendicular and transverse directions. The results of percussion are unsatisfactory. However, one can frequently make out the presence of free fluid at an earlier period than might be expected.

When the conditions above described are found to be present, a diagnosis of strangulation is reasonably certain. True, the intestine may be dilated as a result of peritonitis or of long-standing fecal impaction. But in peritonitis the distention of single loops of intestine is never so distinct, and in fecal impaction the distended intestine is not paralyzed and its peristaltic action is very active.

When a diagnosis of strangulation is made, an immediate laparotomy is indicated. While it is true that a half turn of the sigmoid flexure may produce symptoms of ileus without seriously threatening the life of the patient, and while it is equally true that strangulation of the sigmoid can often be diagnosticated by the small quantity of water which the rectum will hold, still a diagnosis made thus externally is too uncertain, and it is better to open the abdomen in every case in which strangulation exists. (Figs. 86 and 87.)

Unfortunately the diagnosis is by no means always as clear as indicated above. Symptoms of strangulation may have lasted, say, for twelve hours; the most careful examination of the abdomen fails to reveal the presence of any distended motionless loop of intestine, the abdominal distention is slight or wanting, and there are only indefinite abdominal pains referred to the umbilicus or to the left iliac region. All the sites of external hernia are examined and found normal. Examination of the region of the appendix throws no light on the trouble. Nothing abnormal is felt through the rectum or vagina

FIG. 86.



Volvulus of the sigmoid flexure. (Küttner.)

except possibly a little tenderness on the left side. The urine does not show any marked increase of indican, which, of course, could not be expected within twelve hours. Still, the patient is plainly seriously ill. What shall be done? There clearly exists the possibility of intestinal strangulation, and hence the patient must be sent to a hospital or kept under observation where an operation can be performed at any time. An immediate operation is not advised. If the pain is intense, morphine may be given subcutaneously, but one should not wash out the stomach and then give large doses of opium in order to stop peristaltic action. This drug will not overcome strangulation if such exists, and it may still further obscure a sufficiently difficult diag-

nosis. The patient should be seen at short intervals. If the symptoms increase, if the pulse grows worse, and there are signs of collapse, operation should not be postponed beyond the following day. The probability is that a loop of small intestine will be found about the side of the vertebral column or near the uterus. If such is the case, operation will almost certainly save the life of the patient, while if the symptoms are due, for example, to a ureteral calculus, operation will not seriously lessen the patient's chance for recovery.

FIG. 87.

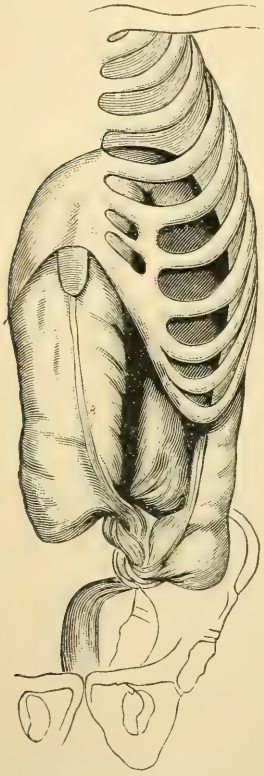
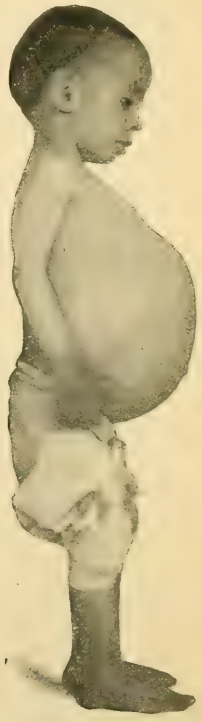


Diagram of volvulus of the sigmoid flexure, as shown in Fig. 86. (Küttner.)

FIG. 88.



Distention of colon due to fecal impaction. Reduced by colostomy. Death from asthenia. No mechanical obstruction. (Griffith.)

If the symptoms of the first day have somewhat decreased on the following day, if the pain is less and the pulse better, and the shock has nearly disappeared, each surgeon must decide for himself whether he will operate or wait until the third day to see if symptoms of strangulation persist or increase. Sometimes a moderately distended loop of small intestine will be found arising out of the pelvis which is easily appreciable but cannot be pushed upward in the abdomen since it seems fixed by its lower end in the pelvis. Such a condition is comparable to many cases of external strangulated hernia in which the

incarceration may exist for three or four days without gangrene because the strangulation at the ring is only moderate. Under such circumstances one should not postpone until the general condition of the patient is less favorable an operation certain to be necessary.

The illustrations given above show the symptoms of strangulation as they appear at an early stage. Unfortunately a surgeon rarely has the opportunity to treat the patient at all so early in the attack. With each succeeding day the condition of the patient changes. The whole abdomen distends with more or less rapidity, and the distention gradually obscures the particular loop which is strangulated. Any peristaltic action or tonic contraction of the intestine which may have been present at an early stage soon disappears. The intestine has passed into a paralytic condition as a result of infection and peritonitis, or as a result of the long-continued overdistention. If a patient is seen for the first time in this advanced stage of the trouble, the original cause of the intestinal paralysis is scarcely to be made out, while the treatment of the same by laparotomy is generally a useless procedure.

If the patient when first seen has a much distended abdomen in which certain loops of intestine may still be recognized by careful palpation, and if light or strong percussion is still capable of causing some peristaltic action which can be recognized if one listens for the resulting gurgle, the diagnosis of diffuse peritonitis with intestinal paralysis may be excluded. A diagnosis of circumscribed peritonitis confined for example to the pelvis is not so easily ruled out. If the history shows that a patient in full health was suddenly seized with abdominal pain, and if the examination does not point to disease of the appendix, the diagnosis of internal strangulation is probable, and if the condition of the patient warrants it, laparotomy is indicated. If he is too weak for radical operation, enterotomy should be performed, since the shock of this operation is slight and it may save the patient from death by gangrene if this change has not already taken place. The strangulated intestine may then be freed at a later period, when the patient is in a condition to withstand the effects of operation.

Diagnosis of Ileus due to Obstruction.—Ileus due to obstruction like that due to strangulation has certain fairly well-marked characteristics:

1. The intense initial continuous pain is wanting.
2. The symptoms of collapse are wanting.
3. There are present clearly marked dilated loops of intestine showing more or less peristaltic action.
4. There will have been before the symptoms of ileus symptoms of abdominal trouble, especially of the intestine.

Usually these characteristics of obstructive ileus will enable one to diagnosticate it from ileus due to peritonitis, and from ileus due to strangulation. It may or may not be possible to determine the exact cause of this form of mechanical difficulty. Take, for example, the case of a patient suffering from chronic intestinal stricture the result of a resection. The patient returned home apparently well, but later began to suffer from indigestion and meteorism, with alternating diar-

rhœa and constipation. He was, however, able to continue his work. Some months later his abdomen suddenly swelled and became painful. Nothing passed from his bowels even after the administration of strong cathartics. He became nauseated and vomited, and later vomited fecal matter. These acute symptoms gradually increased in intensity until at the end of a week the abdomen was fully distended and palpation was very unsatisfactory. Individual loops of intestine could still be made out in different places showing that they were not completely paralyzed. This fact, together with the relatively good pulse, was sufficient to exclude the diagnosis of peritonitis. Could the patient be suffering with strangulation of some small loop of intestine deep in the abdominal cavity? It is true the attack began suddenly, but with only moderate pain and without collapse, and at the end of a week thereafter his condition is fairly good. Strangulation is therefore improbable. In such a case the diagnosis of obstructive ileus rests upon the persistence of peristaltic action and the development of acute symptoms after a long period of chronic intestinal stenosis. The seat of the obstruction in the case mentioned was found to be at the point of previous resection, where the intestine was much narrowed. The acute symptoms were due to a partial twist of the overfull intestine immediately above the stricture.

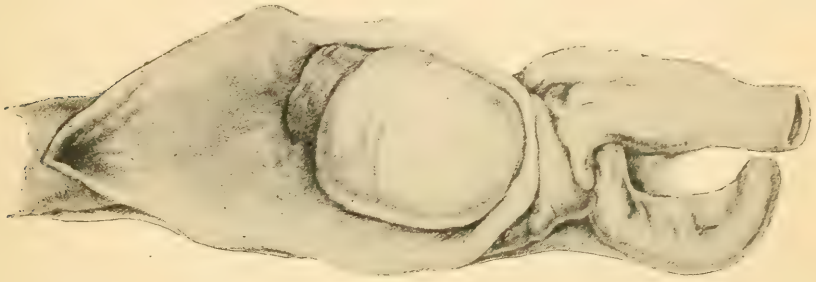
The diagnosis is equally plain if ileus develops in a patient known to have carcinoma of the large intestine or some tumor of the pelvis. If the history does not throw light on the cause of the trouble and the distention makes satisfactory palpation impossible, the prognosis may be obscure. Rectal or vaginal examination will show the presence of a pelvic tumor, if such exists; but carcinoma of the colon and sigmoid flexure will not be palpable by any method of examination. The presence of mucous masses in the rectum suggests a carcinoma of the large intestine, and it is well to remember that in obstruction of the large intestine below the descending colon the rectum will contain only from ½ to 1 litre of water (1 pint to 1 quart). In making this test the water should be injected very slowly at the temperature of the body; otherwise if the patient is sensitive only a small quantity will be retained even though there is no obstruction in the large intestine.

If the abdomen is much distended, it is better not to waste too much time in determining the exact situation of obstruction, since the indication is sufficiently clear that the dilatation of the intestine should be relieved at once.

There is a variety of ileus due to gall-stone, or due to a biliary calculus of a large size that has perforated from the gall-bladder into the intestine. Inflammatory symptoms which accompany such a perforation ought to suggest the correct diagnosis. There will be no jaundice if the process is confined to the gall-bladder, although the colicky pains may closely resemble those produced by the passage of a gall-stone through the common duct. If ileus develops after attacks of colic in women of middle age, the possibility of a gall-stone should

be considered. If the stone perforates into the colon, it causes few or no symptoms. If it perforates into the small intestine, characteristic attacks of ileus are produced with bilious vomiting. If the ileus is situated high up, there may also be vomiting of blood. In such a case the attack of ileus may subside, the gas may escape from the intestine and then the attack recur. Pain is a prominent symptom, as is peristalsis. The symptoms may last months before they are relieved by the passage of a stone into the large intestine, or ulceration and perforation of the small intestine may be the result.

FIG. 89.



Ileocecal intussusception of minor degree. Appendix to the right not yet involved. (Hutchinson.)

The symptoms of invagination are sufficiently characteristic to establish a correct diagnosis. This form of intestinal obstruction is usually found in children. (Fig. 89.) It develops suddenly with intense pain in the abdomen, nausea, vomiting, and tenesmus, with evacuation of blood, or blood and mucus. Afterward nothing passes from the rectum and the abdomen becomes tympanitic. If the patient is seen before the abdominal distention is very great, the cylindrical invaginated intestine may be felt. If so, an exact diagnosis can be made, otherwise the diagnosis will be a probable one.

Treatment of Ileus due to Strangulation.—Laparotomy for strangulation should be performed with good assistance and in circumstances which permit of an aseptic operation. It is particularly useful to wash out the stomach before administering the anæsthetic, since in not a few instances the patient has vomited with fatal inhalation at the beginning or close of the anæsthesia. A general anæsthetic is necessary in order to relax the abdominal walls.

If the place of strangulation is evident, the incision should be made over it. This applies especially to strangulation in connection with some hernial opening; for example, strangulation which continues after the reduction of an external hernia, or chronic or marked intestinal symptoms which continue after the reduction of a hernia and suddenly become acute. Usually, however, the incision is made in the median line from the level of the umbilicus to the symphysis. Before the peritoneum is opened sterile hot cloths should be at hand in order to catch the small intestines since they sometimes pop out

suddenly. The peritoneal cavity is widely opened, and the affected loop of intestine if recognized is carefully brought forward and the constricting band if such exists is divided. This manipulation is easy if the rest of the intestine is empty. If the affected loop of intestine is not seriously damaged, it is replaced in the abdomen and the wound quickly sutured. If the intestine is seriously damaged, the affected portion should be resected. (See page 468.) Schlange has removed 135 cm. (52 inches) of the small intestine on account of strangulation.

If there is volvulus of the sigmoid flexure, it should be untwisted. Since a recurrence of this trouble is rather common, it is well to stitch the untwisted loop to the parietal peritoneum, or to perform resection if necessary.

If a short loop of intestine is strangulated, it usually lies close to the posterior wall of the abdomen, or perhaps in the pelvis, and is often hidden by other distended loops of intestine. In these circumstances much time may be saved by bringing the affected loops of intestine out of the abdominal cavity and wrapping them about with hot moist cloths. When this is done, the source and cause of strangulation are quickly found. Moreover, this manœuvre facilitates inspection of the deeper portions of the peritoneal cavity.

In the treatment of strangulation it is desirable to avoid any tension upon the affected loop of intestine. Its wall may already be gangrenous at the point of strangulation and a careless pull upon it may produce rupture. When a constriction has been divided, the circulation of the affected loop is to be carefully examined, and if there is suspicion that the loop is gangrenous, it should be wrapped about with sterile gauze and brought outside the abdomen while the rest of the intestines are replaced. The abdominal wound is then partially closed by suture and the resection of the damaged intestine is carried out extraperitoneally. The peritoneal cavity should not be irrigated either with antiseptics or with sterile water. Any exudate which it contains at the time of operation should be sponged out.

If the intestine is markedly tympanitic, it is with difficulty replaced. Too much force should not be employed, as tears are thereby produced in the serosa which may lead to further trouble. It is far better to make one or several small incisions in the distended intestine to permit the escape of gas and fluid contents. Every such wound is to be carefully closed by suture and its vicinity carefully washed with sterile salt solution and dried before the intestine is replaced. This step in the operation has another advantage: It relieves the patient of a great quantity of poisonous material situated in the intestine and enables the latter more easily to resume its normal function.

Treatment of Obstructive Ileus.—The most important point in the treatment of obstructive ileus is the speedy relief of the distended intestine. This is accomplished by means of an artificial anus. Ileus due to strangulation requires an immediate laparotomy in order to prevent threatened gangrene, whereas the slight operation necessary for the

establishment of an artificial anus can be performed under local anæsthesia with very little risk to the patient. When the intestine has become freed from its putrid contents, which have much the same injurious effect upon the organism as the contents of a large putrid abscess, the vomiting subsides and the condition of the patient rapidly improves. At a later period laparotomy and a radical operation can be carried out under much more favorable conditions.

Enterotomy is necessary for another reason. The circulation in the distended intestine is suspended if distention reaches a certain point even though the vessels of the mesentery are unaffected. There may follow venous stasis with ecchymoses and ulcerations of the mucous membrane, and possibly perforation and peritonitis. But long before perforation occurs bacteria may pass through the damaged intestinal wall and set up infection. These ulcers of the mucous membrane, to which Köcher has given the name dilatation ulcers, are not the result of pressure from hardened fecal lumps since they occur in the small intestine as well as the large intestine. Their significance is very great as they permit the escape of bacteria and the development of sepsis which is frequently fatal.

The affected intestine should be opened as near the point of obstruction as possible, for there its dilatation is the greatest and the escape of gas and feces will most easily be accomplished. Moreover, by making the opening as far as possible from the stomach the nutrition of the individual will be best preserved.

Sometimes the site and cause of obstruction cannot be determined and the history may fail to indicate the nature of the obstruction. A safe rule to follow in these cases is to cut down directly upon the obstruction when its situation is known. Otherwise an incision should be made over the cæcum. The obstruction in these cases is usually in the large intestine, and an opening made in the cæcum will preserve the function of the whole of the small intestine. If the cæcum is found collapsed, the affected loop of small intestine can be searched for and brought out through the wound already made.

The incision should be about 6 cm. (2.4 inches) long, similar to the incision made for appendicitis. A peritoneal incision 3 cm. (1.2 inches) long will usually suffice for inspection and palpation of the cæcum and the subsequent incision in it. The bowel to be opened is first stitched in the peritoneal wound with interrupted or, better, continuous catgut or silk sutures. The incision in the bowel should be made longitudinally 2 cm. (0.8 inch) in length and its cut edges fastened to the skin. If the contractility of the intestine is preserved, there will be an immediate escape of gas and fluid fecal matter. This is in sharp contrast to the sluggish escape when the opening is made in an intestine which is distended by peritonitis.

The intestine should be emptied as thoroughly as possible. As soon as the intestine is firmly adherent in the wound it should be cleansed by irrigations and laxatives should be administered to the patient. Until such time nourishment should be given by the rectum, and in

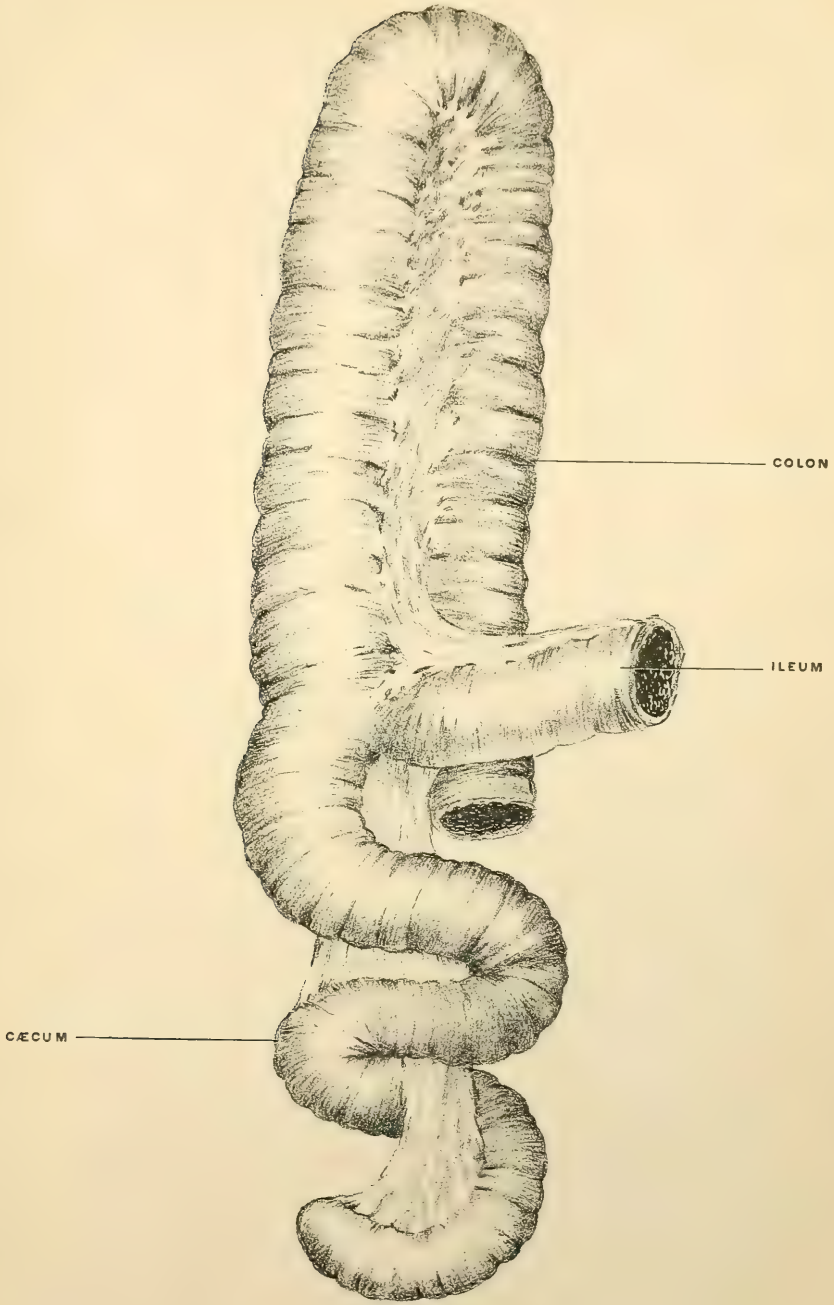
serious cases no fluid should be given by mouth, but the necessary amount should be administered in the form of subcutaneous saline injections. If there has been fecal vomiting, it is well to wash out the stomach.

The diagnosis of gall-stone ileus is usually a probable one. Even if it is certain, the severity of the attack cannot be foreseen, so that it is safer in all such cases to open the abdomen and to follow the distended small intestine to the point of obstruction. The stone is usually easily palpable. The loop of intestine which contains it should be brought out of the abdominal cavity, and the incision in the abdominal wall partially closed by suture. The intestine is then incised, the stone removed, and the wound in the intestine sutured. The intestine is then replaced and the abdominal wound sutured. If operation is performed early, a complete cure may be expected. If there have been repeated attacks with more or less ulceration of the intestine, all the symptoms will not at once subside.

There are other simple measures which sometimes succeed in reducing invaginated intestine. These are: injection of water from a fountain-syringe or funnel, distention of the rectum and colon with air, and direct reposition through the anus of the invaginated bowel in case the trouble is situated low down. If these measures fail, a laparotomy should at once be performed. The results of operation are naturally better if it is performed early. When the abdomen has been opened, it may be possible to reduce the invagination even though it has lasted two or three days. If manipulation fails, resection should be performed. The results of enterotomy in these cases are not so good as those of resection, and the former operation should therefore be reserved for patients who cannot withstand the more radical procedure.

It must not be inferred from what has been said concerning the treatment of ileus that every case demands operation. On the contrary, many patients suffering from dynamic ileus or from acute or chronic peritonitis, or from fecal obstruction, or from ileus due to hysteria, or spasm of the intestine, have recovered without operation. Moreover, in spite of improved methods of diagnosis there are still a few cases in which it is not possible to determine the nature and cause of the ileus with certainty. But in this class of cases delay works more harm than good, and therefore an early operation is strongly to be advised.

PLATE VI.



Lemur Mongoz, Lemur. Ileocolic Junction and Cæcum. (Drawn from Preparation.) (Columbia University Museum, No. 1473.) (Huntington.)

CHAPTER XVII.

APPENDICITIS.

ANATOMY AND ETIOLOGY.

Before its cause was understood inflammation in the neighborhood of the cæcum received such names as typhlitis stercoralis, paratyphlitis, iliac abscess, etc. Since it has become recognized that most of the inflammation in this neighborhood begins in the appendix the term appendicitis has come into general use. Objection has been made to it on the ground that it combines a Latin root with a Greek termination, and those who are much disturbed by this name employ the term perityphlitis. The term appendicitis is now so thoroughly popularized that it seems doubtful if any other will succeed in supplanting it. It will therefore be used in this Surgery.

The vermiform appendix in man as well as in many apes is the rudimentary representative of the long cæcum which exists in many lower animals. It is usually covered with peritoneum and possesses a mesentery of varying length. The wall of the appendix is similar to that of the colon. Its mucous membrane is so abundantly provided with such glands as are found in the cæcum that scarcely any tissue intervenes between them. According to Ribbert, the follicles preserve their arrangement and form until the thirtieth year of life. At this time or perhaps a little sooner they degenerate with a regularity which gives a physiological character to the process. Atrophy of the mucous membrane is the result. The lumen of the appendix is separated from the cavity of the cæcum by a semicircular fold of mucous membrane called Gerlach's valve. This valve obstructs the passage of fecal matter into the appendix.

The mesentery contains nerves, lymph-vessels, veins, and an artery which springs from the superior mesenteric and feeds the appendical wall by means of anastomosing branches. In women there is also an arterial supply through the appendicular-ovarian ligament. The nerves of the appendix are derived from the mesenteric plexus of the sympathetic.

The position of the appendix varies. It is usually behind and to the inner side of the cæcum, but the cæcum itself does not occupy a fixed position in the abdomen. The origin of the appendix in the cæcum may be placed further to the right or left, while its tip may be directed toward any point in the circumference drawn about its base. Thus in some cases it is wholly retroperitoneal.

The appendix is most often situated on a line between the anterior superior spine of the ilium and the umbilicus—about 6 cm. (2.4 inches) from the first-mentioned point.

The normal length of the appendix may be given as between 5 and 8 cm. (2 and 3.2 inches). In a very few cases it is wanting or represented by a mere stump, while in a few other cases it measures from 16 to 23 cm. (5.4 to 9.2 inches). The lumen usually measures from 4 to 5 mm. (0.1 to 0.2 inch) in diameter.

Inflammation of the vermiform appendix is due to bacterial infection; but this infection may be produced by a variety of micro-organisms. Several dozen at least have been isolated from the contents of the inflamed appendix as well as from the peri-appendicular exudate. But pus cocci and bacterium coli are by far the most frequently found. Since these bacteria are regularly found in normal appendices, it is necessary to presuppose some exciting cause for the inflammation. This is found in the anatomical peculiarities of the appendix. It is well known that bacteria are taken up by the tissues of animals or men wherever they exist under pressure. This is equally true in case of the skin, mucous membrane, or surface of a wound. Such an increase of pressure can easily exist in the long, narrow, and frequently tortuous lumen of the appendix. A moderate swelling of the mucous membrane, at Gerlach's valve or at some other point, may obstruct the secretion of the appendix and increase the pressure within its lumen beyond the obstructing point. This is the more likely to happen if the serous coat of the tip of the appendix is fixed by adhesions, since then a kinking of the organ is often produced.

There is still another factor in the production of inflammation. Ribbert and Zückerkandl found a partial or complete closure of the appendix in about 25 per cent. of the cases examined. This obliteration of the lumen was formerly supposed to be due to inflammatory processes. Further examination has shown that it is a process of involution which may begin as early as the fifth year of life, and which is present in more than one-half of the appendices of persons who have lived sixty years or longer. An appendix which is the subject of this involution need not be adherent nor show any symptoms of inflammation. The follicles shrink, the mucous membrane atrophies, and the walls of the appendix grow together. The submucosa becomes thickened by a deposition of fat and the muscular layers undergo fatty degeneration. As a result the whole appendix may be changed into a connective-tissue string which is, of course, without danger for its possessor, or its lumen may be obliterated only in certain places. It is natural that a surgeon who sees chiefly inflamed appendices should associate these strictures with existing inflammation, but they are not necessarily inflammatory in character.

In structure the mucous membrane of the appendix closely resembles that of the tonsils. Both are the seat of frequent inflammation, and especially in early years before the follicles atrophy. By far the majority of cases of appendicitis occur between the tenth and thirtieth

PLATE VII.

FIG. 1.

FIG. 2.

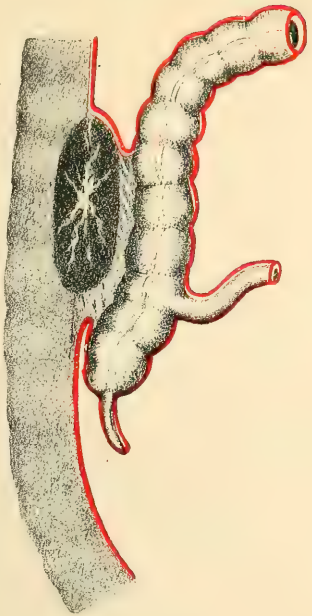
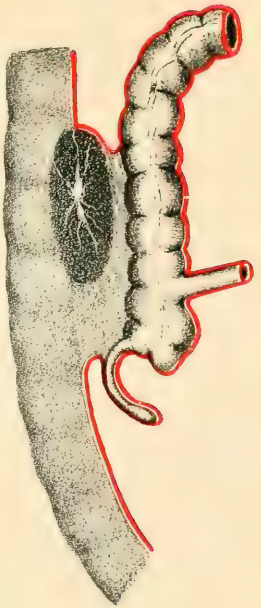


FIG. 3.



Schematic Series Illustrating the Variations in the Arrangement of the Cæcal and Colic Peritoneum. (Huntington.)

PLATE VIII.

FIG. 4.

FIG. 5.

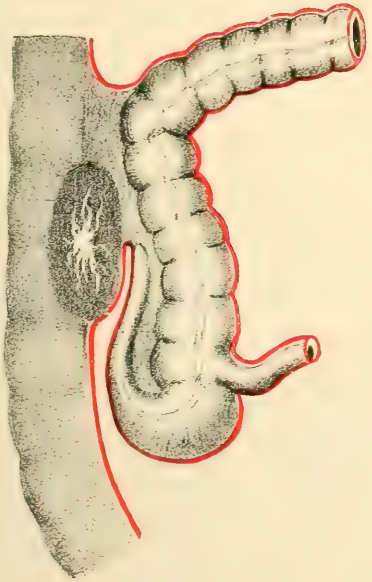


FIG. 6.

Schematic Series Illustrating the Variations in the Arrangement of the Cæcal and Colic Peritoneum. (Huntington.)

EXPLANATION OF PLATES IX., X., XI., AND XII.

Fig. 1.—Acute appendicitis; rupture threatened. Immediate operation, with temporary drainage. Good recovery.

Fig. 2.—Acute gangrenous appendicitis. Removal of appendix, with drainage. Recovery.

Fig. 3.—Acute gangrenous appendicitis: first attack. The appendix contained a fæcal concretion, but was not perforated. Removal of appendix, with drainage. Recovery.

Figs. 4 and 4*a*.—Acute appendicitis, with fæcal concretion and two perforations. Outside and inside views of the appendix. Removal of the appendix and drainage. Recovery.

Figs. 5 and 5*a*.—Gangrenous appendicitis. A perforation near the cæcum, but not involving it. Outside and inside views. Removal of appendix on the third day of the attack. Recovery.

Figs. 6 and 6*a*.—Acute appendicitis, with perforation. Outside and inside views. Removal of the appendix and drainage. Recovery.

Fig. 7.—Acute appendicitis, with gangrene and perforation. Removal of appendix and drainage. Four weeks later operation for intestinal obstruction due to a band. Recovery.

Fig. 8.—Acute appendicitis, with gangrene. Operation several days after first symptoms. Removal of appendix and drainage. Recovery.

Fig. 9.—Acute appendicitis, with gangrene of the whole appendix, in a child aged eight years. Removal of appendix and drainage. Recovery.

Fig. 10.—Acute appendicitis, with complete gangrene. Removal of appendix and drainage. Recovery.

Fig. 11.—Chronic appendicitis. Operation in the interval. Recovery.

Fig. 12.—Chronic appendicitis. Operation in the interval. Recovery.

Fig. 13.—Chronic appendicitis. Several attacks. Operation in the interval Recovery.

Fig. 14.—Chronic appendicitis. Several attacks, one followed by the discharge of pus through the vagina. Operation in the interval. No drainage. Recovery.

Fig. 15.—Chronic appendicitis. Operation in the interval. Recovery.

Figs. 16 and 16*a*.—Chronic appendicitis. Outside and inside views. Operation in the interval. Recovery.

Fig. 17.—Chronic appendicitis. Operation in the interval, with drainage on account of old inflammation. Recovery.

Fig. 18.—Chronic appendicitis. Removal of appendix and part of the Fallopian tube.

Fig. 19.—Chronic appendicitis. Operation in the interval. Recovery.

Fig. 20.—Chronic appendicitis. Several previous attacks. Removal of appendix in the interval. Recovery.

PLATE IX.

measures 1 cm. (0.4 inch) in diameter. Perforation may be situated at the tip of the appendix or any other portion of its length. Perforation may take place into the free peritoneal cavity, or, as frequently happens, protecting adhesions between the coils of intestine in the neighborhood may shut off the general peritoneal cavity so that the abscess when it forms is encapsulated. The pus of the abscess may at a later moment break through such adhesions and lead to extension of the inflammation.

The disturbances of circulation in perforative peritonitis may be so great that a major portion of the appendix becomes gangrenous. The black, or greenish, or gray necrotic appendix may become separated

FIG. 91.

Empyema of the appendix. Much dilated appendix split open longitudinally: *S*, stricture near the cæcum.

and be found floating in the base of the abscess cavity, or it may be so disintegrated that it is not found at all. In such circumstances one speaks of a gangrenous peritonitis. In such a case at an early stage the serosa will still have strength to prevent the escape of putrid contents into the peritoneal cavity.

The peritoneum, or at least a part of the peritoneum, is involved in almost every case of appendicitis. There are doubtless instances in which a transitory catarrhal inflammation may exist without affecting the peritoneum; and according to Nothnagel and others, chronic ulcerative inflammation of the mucous membrane may exist without any peritoneal adhesions. Such cases are decided exceptions.

In the usual slight inflammations of the appendix the serosa is reddened and adheres to surrounding peritoneal surfaces by a delicate fibrinous exudate. These adhesions become firmer and are finally changed to connective tissue. If the inflammation is more intense, the extent of this adhesive peritonitis may be far greater, so that not only the appendix, but also the surrounding portions of the small and large intestine, omentum, etc., may be matted together. It is evident that such adhesions may produce kinks and functional disturbances in both the appendix and small intestine.

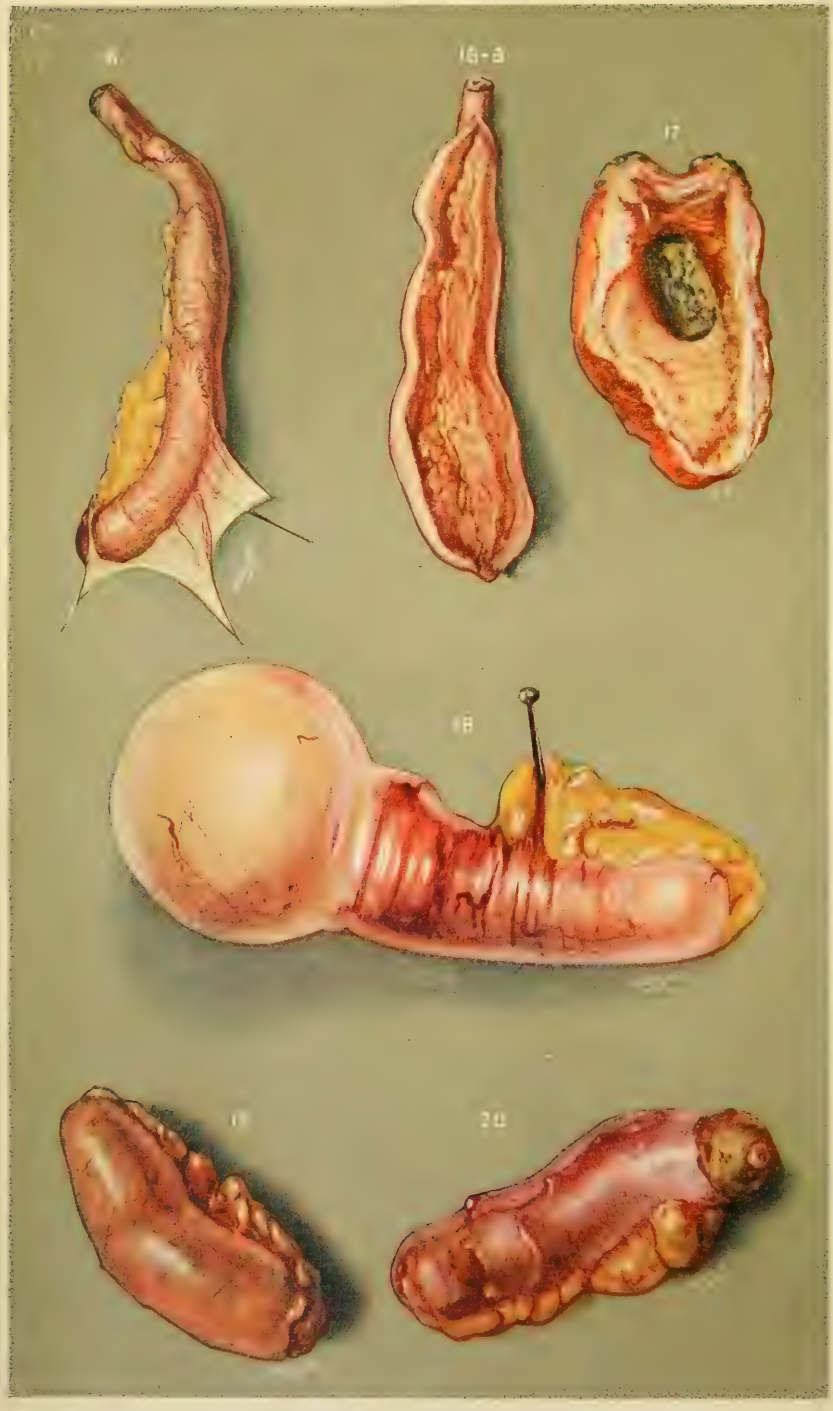
If the inflammation in the appendix is ulcerative, perforation does not necessarily follow, as the result may be an exudative peritonitis of the fibrinous character described, or of a serous or infectious, suppurative character. These circumscribed inflammations in the neighborhood of the appendix produce a more or less distinct swelling entirely apart from any accumulation of fecal matter which may coexist in the cæcum. The swelling is due to the inflammatory infiltration and œdema of the tissues in the neighborhood of the appendix, and also to the matting together of the surrounding loops of intestine by the fibrinous deposit upon their peritoneal surfaces. There is often an accumulation of fluid close by the appendix. If perforation exists, this fluid will be purulent, and will often contain a fecal concretion or smaller particles of feces. The condition is then spoken of as a peri-appendicular abscess. Even without perforation a considerable amount of serous or serofibrinous fluid may accumulate in the neighborhood of the appendix.

The quantity of fluid in a peri-appendicular abscess is at first small, being merely the escaped contents of the perforated appendix. It may increase rapidly, so that in a day or two the existence of an abscess is most evident.

It is beyond question that the contents of a small abscess may be resorbed. This has taken place in cases in which diagnosis was confirmed by aspiration. Such is a rare outcome of the trouble. A more frequent result is rupture of the abscess into the intestine, usually into the cæcum. Such rupture may take place into the small intestine, rectum, urinary bladder, uterus, or gall-bladder. If the pus in the abscess does not promptly escape, it tends to extend in the direction of least resistance. As it breaks down existing adhesions others may form so that the free peritoneal cavity is protected. In this way the pus may work up to the outer side of the ascending colon into the region of the kidney, and even into the diaphragm, where it forms a subphrenic abscess. It has been known to perforate the diaphragm and the lung, and to escape by coughing. It may also work outward into the pelvis and collect between the rectum and bladder; or, following along the left wall of the pelvis, it may appear above the left Poupart ligament. In such cases the small intestine is more or less affected and its coils become adherent. The pus may also burrow in the retroperitoneal tissue. If the abscess ruptures externally, it usually does so in the right iliac region. The point of rupture

PLATE XI

PLATE XII.



may be below Poupart's ligament, or it may be at the umbilicus or in the lumbar region. The fistulous tract thereby produced is often tortuous, and spontaneous recovery of the patient is delayed or never occurs.

Often only a part of the contents of the abscess is discharged or some portion which remains behind again becomes encapsulated and an abscess results.

In some cases the pus has eroded the wall of the internal iliac artery, or the circumflex iliac artery, and has produced severe hemorrhage. A more frequent complication is thrombosis and rupture of a vein giving rise to suppurative thrombophlebitis. This is an accident which is more likely to occur in slowly progressing cases in which the quantity of pus is small. The affected vein may be a branch of the portal vein or a radicle of the inferior vena cava. Such venous invasion will result in numerous pyæmic abscesses in the liver, retroperitoneal glands, spleen, kidneys, or lungs, or in endocarditis, meningitis, abscess of the brain or parotid gland, or other metastatic abscess. Non-suppurating thrombophlebitis of the right iliac vein may also be produced with the well-known consequences.

All of the complications above mentioned may be produced without extension of the inflammation to the general peritoneal cavity. Unfortunately in many cases protective adhesions fail and a diffuse peritonitis results. There are in many cases of circumscribed appendicitis symptoms of diffuse peritoneal irritation, such as general abdominal distention and tenderness. The intestine may be hyperæmic, and there may be a slight serous exudate. Such a condition is quite different from diffuse peritonitis, and must not be confounded with it. In favorable cases these symptoms of peritoneal irritation will disappear in a few days.

In other cases of appendicitis the inflammation almost from the start will spread rapidly throughout the free peritoneal cavity. This is usually due to perforation or gangrene of the appendix, so that a considerable quantity of infectious and perhaps unusually virulent material finds its way into the cavity of the peritoneum. In these cases of severe septic or purulogangrenous peritonitis one is often astonished to find that there is very little inflammatory infiltration in the region of the cæcum. This failure of protective adhesions may be due to the rapidity of the disease or to the nature of the parasite. In other cases adhesions form, but they prove insufficient to confine a rapidly growing abscess, so that the abscess breaks through them and produces suppurative peritonitis often with fatal result. The most favorable form of diffuse peritonitis is the so-called fibrinosuppurative peritonitis of the progressive type. In this form the inflammation extends step by step until the pus occupies a considerable portion of the peritoneal cavity or is disposed in solitary abscesses which are shut off by adhesions between the coils of intestine.

SYMPTOMS.

For the sake of clearness, it is well to group symptoms which may arise during an attack of appendicitis under three heads: *a*. Symptoms which are due to disease of the appendix itself. *b*. Symptoms which are associated with the peri-appendicular inflammation. *c*. Symptoms of diffuse peritonitis or other outcome of the trouble.

a. **Symptoms of Appendicitis when the Inflammation is Limited to the Appendix.**—The pathological changes which take place in the appendix during an attack of inflammation of this organ are, as stated above, a severe catarrh with hemorrhage or ulcers of the mucous membrane. A rapid restoration of the normal condition is interfered with by the stenosis which these lesions produce, so that the course of the trouble is apt to be marked by exacerbations when stenosis interferes with the discharge of secretion, alternating with periods of improvement when such discharge takes place. It is well, therefore, to separate the symptoms into those which exist during an acute attack and those which exist in the intervals between attacks.

There are certain symptoms which may be regarded as preceding a first attack. These are transitory colicky pains in the abdomen, slight disturbances of the stomach, intestine, liver, kidneys, or bladder, without visible cause therefor, pains which are often called rheumatic, or nervous, or hysterical, or which in women are frequently referred to the pelvic organs. If one makes a careful examination of such a patient, he will usually find the appendix vermiformis somewhat tender on pressure. These symptoms may or may not precede the first attack. The latter is marked by an intense, sudden boring pain in the abdomen which cannot be localized, or is referred to the epigastric or umbilical region. There is often nausea and vomiting or diarrhœa. If one makes a diagnosis solely on the statement of the patient, he may easily mistake the attack for one of gastric catarrh, indigestion, etc. Sonnenburg says that nausea and vomiting invariably occur after the pain in appendicitis, whereas in gastritis or enteritis the reverse may be true. The abdomen is often evenly distended, though different portions of it may be more sensitive to pressure. The complete extension of the right thigh is avoided by the patient. There may or may not be fever. The latter may be preceded by a chill. Usually the disturbance of the general condition of the patient does not last long, and on the following day the temperature may be normal while the meteorism and tenderness on pressure vanish. The more careful examination of the abdomen which is thus permitted will usually show that the inflammation is located in the ileocæcal region. Pressure in this region may be very painful. Gentle palpation will usually reveal the situation of the thickened appendix, or one may detect only a sense of resistance due to the swollen appendix and the inflammation in its immediate neighborhood. The diagnosis is then sufficiently clear. Diseases of the pelvic organs can ordinarily be eliminated by a careful pelvic examination.

In a few days, or at the most a week, the patient is usually so far recovered that all subjective disturbances have disappeared. It is, of course, important to know whether the patient is permanently cured or whether the disease is likely to recur. No one can give a definite answer to this question. If the attack was due to an accidental swelling of the mucous membrane or to obstruction by a fecal concretion, the passing of the cause may be followed by a complete restoration to health; but, as shown in the preceding pages, there are usually important anatomical changes of a permanent character which are increased by the first attack on account of the doubtful condition in which such an attack frequently leaves the appendix, so that it is usual for the patient to suffer from a second attack within a period of weeks or months, or in a few cases years. Neither is it by any means certain that the second attack will prove as mild as the first. If a second attack occurs, it is usually ascribed by the patient to some traumatism or an error in diet, or exposure to cold.

Even in the interval the patient is not entirely free from symptoms. These are usually of the character described above as prodromal symptoms, and there is besides a feeling of heaviness or weight in the sacral region which is more or less constant. Sometimes these slight subjective symptoms, combined with a fear of recurrence, cause the patient to lead the life of a chronic invalid and prevent him from taking active exercise and interest in matters outside of himself which are so essential for healthy existence.

There are, however, cases in which the patient feels absolutely well after a first attack and believes himself permanently cured until suddenly a new attack dispels this illusion.

b. **Symptoms of Appendicitis accompanied with Peri-appendicular Tumor and Abscess Formation.**—The intensity of the symptoms in this form of disease is naturally greater. There are severe pain in the whole abdomen, chill and fever, repeated vomiting, possibly of a bilious character, diarrhœa followed by obstipation, and often such symptoms of collapse as cyanosis, perspiration, and small rapid pulse. The abdomen may be distended or the abdominal wall may be contracted as hard as a board. The slightest touch on the abdomen causes pain and the patient carefully avoids any unnecessary motion. It is evident that there is a diffuse affection of the peritoneum of a serous or serofibrinous or fibrinopurulent character. If the condition of the patient gradually improves, and the abdominal tenderness disappears except in the neighborhood of the cæcum, the diagnosis of appendicitis is evident, and that of diffuse suppurative peritonitis can be ruled out. Such a stormy attack makes probable the formation of an appendical abscess. This is usually due to perforation of the appendix, although an equally violent attack may be the result of an infection spread through the lymph-channels.

When the pain has become limited to the region of the cæcum and the spasmodic contraction of the abdominal muscles has somewhat subsided, palpation of the abdomen will reveal the presence of a tumor

about the appendix. This varies in size from that of an egg to that of the fist. The mass is tender on pressure, hard, immovable, and the skin may be already affixed to it and somewhat œdematous. In some instances the centre of the swelling projects beyond the normal level of the skin. A like swelling may be sometimes seen in simpler cases of appendicitis due to a serofibrinous exudate which does not contain bacteria. Such a swelling rapidly diminishes until only a thickened appendix with some adhesions is left to mark its presence. If the swelling is due to pus, it does not disappear, but remains tender, or its tenderness may even increase for four or five days. Meantime the swelling remains stationary or increases in size, and the œdema of the skin becomes more evident. This is sufficient proof of the existence of pus, although fluctuation is obtained only in occasional instances.

The temperature and pulse curves are important, although there is no distinct type characteristic of the disease. As a rule there is more or less fever. Exceptions have been reported, but they are extremely rare. The temperature reaches 39° or 40° C. (102°–104° F.) at the first, to fall to normal in two or three days if the attack is a simple one. If the temperature remains at about the same height for five days, the presence of an abscess is practically certain. There are also cases of abscess in which the temperature becomes normal in four or five days, and then gradually or suddenly rises again. The pulse curve for the most part corresponds to the temperature curve. Indeed, the variations in the pulse are a more sensitive indication in some cases than variation in the temperature. A rapid pulse is always a suspicious symptom. In describing the symptoms of appendicitis it has been assumed that the appendix is situated in its normal position. If it is so situated that an abscess forms by the outer margin of the cæcum, the area of induration will reach the iliac spine. On the other hand, an abscess may be formed so far inward as to reach the median line. If the appendix is situated behind the cæcum, a retrocæcal abscess may be formed. In this case the anterior abdominal wall will not be affected and the abscess will be covered with resistant intestine. If the pus extends upward to the liver, the lumbar region is generally tender and the right thigh is flexed and adducted. Pus in the pelvis produces disturbances of the bladder, and not infrequently annoying tenesmus or intense sacral pain. Examination by rectum or vagina ought never to be omitted. If there is pus in the pelvis, a tender resistant mass can be felt in Douglas's pouch. If the inflammation from the appendix has extended to the tube and ovary or has proceeded in the reverse direction, an exact diagnosis may be difficult.

The abscess may extend into the sac of a right inguinal hernia or an unusually long appendix which reaches into a hernial sac may become inflamed. In such circumstances the symptoms will resemble those of acute strangulation.

c. **Termination of Appendicitis in Diffuse Peritonitis and other Complications.**—Abscess around the appendix may in certain in-

stances terminate in spontaneous cure. The pus may become sterile and be resorbed. It is also conceivable that the pus may discharge from the appendix into the cæcum even after the appendix has perforated. Rupture of the abscess into the cæcum or rectum will more promptly relieve the symptoms. The pus will then appear in the stools for one or more days. Cure may also follow the discharge of pus into the bladder, uterus, or vagina, or through the skin, but the relief of an abscess in these cases is often merely temporary, and it either re-forms or a fistula persists. The development of subphrenic abscess and right-sided pleurisy is another termination which has been spoken of.

Rupture of an abscess into a vein may produce suppurative thrombosis and pyæmic metastatic abscess, or the patient may die of sepsis.

The abscess may become surrounded by such a mass of cicatricial tissue that the condition simulates the infiltration of actinomycosis. Such a condition is accompanied by slight or no fever, but the patient will be anæmic and will show loss of strength.

By far the most important complication of appendicitis is diffuse inflammation of the peritoneum. This may take place before adhesions have formed around the appendix or the pus may break through such adhesions and spread the infection beyond them. (See page 355.)

The tendency of appendicitis to recur after spontaneous recovery has been already spoken of. Unfortunately it is not possible to say in a given case whether or not a recurrence is to be expected. Rotter treated 221 patients, 47 of whom had had previous attacks, equal to 21 per cent. Statistics of Sahli show that 20.8 per cent. of 4593 cases were of the nature of recurrences. The probability of recurrence may therefore be given as about 20 per cent. Rotter says that in most recurrent cases there is a second attack, but that it is rare to have more than one recurrence and that this single recurrence may usually be looked for within a year, and very seldom after two years. Autopsies show that perforation does not take place in more than one-half of the recurrent cases.

DIAGNOSIS.

In most cases of appendicitis, whether acute or chronic, the diagnosis is easily made from the symptoms described in the preceding pages; but if the appendix is not in its usual situation one may be misled, especially in the beginning of the affection. The differential diagnosis must include renal or biliary calculus, perforation of the stomach, diseases of the pelvic organs, and intestinal strangulation and obstruction. Sometimes the question may lie between indigestion and appendicitis, or acute intestinal catarrh, or fecal impaction, or some form of intoxication. If the appendical tumor has existed a long time, one will have to consider the possibility of ileocæcal tuberculosis and malignant new growth. The flexed position of the thigh suggests psoas abscess or hip disease.

In other instances diseases of the urinary bladder or rectum and

neuralgia will require exclusion. It is a safe rule to consider the possibility of appendicitis in every case of abdominal trouble not clearly due to something else. The appendix may be the starting-point of an abdominal abscess wherever placed, as well as the cause of sepsis or pyæmia of obscure origin. The presence of dulness in the cæcal region on light percussion, a sense of resistance and increased tenderness when the cæcal region is gently palpated, will suffice to make the diagnosis certain in many cases. Any superfluous palpation should be avoided not only because it is painful, but also because it is capable of rupturing existing adhesions or perforating the appendix.

Puncture to prove the existence of an abscess is an unwise procedure. If the abscess is large, it is unnecessary ; if the abscess is small, the point of the needle may miss it. It is in any event a painful procedure, and carries with it the risk of spreading the infection.

Tuberculosis of the appendix is in the majority of cases simply one manifestation of tuberculosis which is widely scattered through the organism or at least through the intestinal tract. If the ileocæcal region alone is involved, the slow course of the disease and its mild symptoms will suggest its true nature. Swollen and caseous retroperitoneal glands may be palpable. The symptoms are mild until stricture or adhesions bring about stenosis. For other symptoms of tuberculosis the reader is referred to page 320.

Actinomycosis often begins in the appendix or its neighborhood, but the course of this disease is so typical that it can scarcely be mistaken for appendicitis. The pallor of the patient, and the extensive infiltration of the abdominal wall which has developed without any acute symptoms, fail to distinguish this disease from appendicitis. At a later period there are fistulas and abscesses. (See page 326.)

PROGNOSIS.

In speaking of the prognosis of appendicitis one must distinguish between the particular attack and the whole course of the disease. Any statistics to be of value must be collected with this in mind, and statistics intended to show the prognosis of a single attack ought to separate slight attacks from severe ones. Rotter follows this plan, and reports that of 110 patients with slight or circumscribed appendicitis 2 died and 8 were operated upon, leaving about 90 per cent. in which spontaneous recovery occurred. In 9 cases in which appendicitis was complicated with diffuse peritonitis there was not a single spontaneous recovery. The significance of recovery from a particular attack has been discussed in the preceding pages. Moreover, the mortality of appendicitis is doubtless greater than appears from statistics, for the reason that the diagnosis made in fatal cases—for example, ileus, diffuse peritonitis, chronic pyæmia, abscess of the liver, etc.—does not show that the origin of the trouble may have been in the appendix.

While it is doubtless true that the majority of attacks of appendi-

citis are recovered from without operative treatment, yet every attack must be looked upon as serious the prognosis of which is in doubt. A favorable outcome cannot be assured until the inflammatory process is plainly limited to the cæcal region and the inflammatory tumor begins to diminish in size. Even then one should bear in mind that the period of recovery is uncertain, and that another attack may occur at any time.

TREATMENT.

Appendicitis is now generally recognized as a disease which should be treated surgically, or at least one in which surgical treatment should be constantly under consideration. Formerly operation was looked upon as a last resort. Fortunately the advantages of early surgical interference are now generally understood. In the early stages of the disease before the diagnosis is certain the patient should be kept absolutely at rest, and should be given a restricted fluid diet, a moderate amount of opium, and, if necessary, morphine to control the pain. Ice or hot cloths should be applied to the abdomen. Cathartics and large rectal injections are inadvisable since they stimulate peristaltic action and may drive fluid fecal matter through the perforated appendix. These measures will be successful in bringing many patients through an attack of appendicitis; but as one never knows when a serious complication may arise, the patient should be removed to a hospital unless his surroundings permit the speedy performance of an operation should such become necessary. If the patient is moved, he should be kept constantly in a horizontal position upon a bed or stretcher so as to avoid any jarring or straining of the abdomen.

It is generally agreed that an appendical abscess demands operation in order to draw off the pus, and by removal of the appendix to provide against a recurrence of the trouble. Some surgeons advocate an early operation because its risk is slight. Dangerous complications are thereby avoided and subsequent formation of a fistula or a hernia is less likely. Other surgeons postpone operation until there is a definite abscess, which they open, at the same time removing the appendix if it is easily accessible. Otherwise they postpone its removal for four or six weeks until the symptoms of inflammation have subsided. While both sides to the controversy support their positions by the favorable results of their respective treatment, the principle which underlies an early operation is logically right, and is likely to prevail. As an early operation to succeed requires a certain amount of dexterity and experience, those who are not fortunate enough to possess these requisites will subject their patients to less risk if they postpone operation until an abscess has formed.

Experience has shown the value of certain methods of procedure which are well worth consideration:

1. There is a relatively large group of cases of appendicitis in which the attack is from the start of slight character. Since the gen-

eral condition of the patient is little affected, there is not much infiltration of the tissues and the fever is slight or becomes so by the third day. In such a case an operation is counterindicated, although the patient or his nurse should be advised that it may become necessary at any time. Furthermore, one should point out the probability of recurrence so that operation in the interval may be performed if desired.

2. In contrast with these mild cases are very severe ones in which the disease begins and continues with an intensity that augurs ill for the patient. There is more or less fever, an abdomen uniformly distended and tender, but no distinct tumor in the region of the appendix. The patient appears very sick. The pulse is rapid, and perhaps small and irregular. Almost all these patients die without operation, and the greater number of them die if operated upon, but some of them can be saved if operation is promptly performed. If the pulse has still some force and other symptoms do not indicate that the disease is beyond control, a free incision should be made under local anæsthesia in the region of the appendix in order to rid the abdominal cavity of a great quantity of infectious material.

3. There is a third group of cases which lie between the extremes just mentioned, and which are characterized by a tendency of the inflammation to become localized and to form a distinct tumor. In such cases one has almost always to do with an abscess; but whether this is large or small, it should be treated as soon as possible by operation, preferably not later than the third day. In cases of doubt it is better to operate in a slight attack rather than to trust to spontaneous recovery when perhaps an abscess exists.

4. In these cases opening of an abscess should be combined with removal of the appendix provided the operator has the necessary skill to perform this operation without much delay. Failing in this, or if the removal of the appendix is going to be too difficult, one should content himself with evacuation of the abscess. If removal of the appendix is not contemplated, local anæsthesia will suffice.

5. Whatever the skill of the operator, he should not insist upon removal of the appendix if it is so situated that its removal will greatly complicate the operation.

6. If an abscess is opened and for one reason or another the appendix is not removed, its removal should be accomplished after the symptoms of inflammation have subsided, but before the wound is firmly cicatrized; that is to say, in four or six weeks. It is true that in some cases the appendix is destroyed by the inflammation, so that there may be no further attack. This is, however, the exception, and therefore it is better to remove the diseased organ.

7. Subsequent operation is an absolute necessity when suppuration continues or abscesses re-form from time to time, or when a fecal fistula persists. Such a fistula will in most instances be found to lead into the appendix, although sometimes it is connected with the cæcum or small intestine. In any case it will be necessary to expose the diseased parts and to remove the remains of the appendix.

8. Removal of the appendix in the interval between attacks is indicated when there are chronic symptoms clearly referable to the appendix. Such symptoms are continued tenderness in the cæcal region, a feeling of heaviness and pressure, obstipation, and digestive disturbances. A chronic inflammation of the appendix predisposes to renewed acute attacks.

9. Removal of the appendix is also advisable even though the recurrent attacks are slight and have never produced an abscess.

10. In performing this operation it is necessary to expose the cæcum and to divide adhesions of the intestine or omentum, as these frequently cause severe pain. Adhesions of the omentum may compress the intestine, or such pressure may be produced by the long adherent appendix, or the adherent omentum may contract to such an extent that there is a marked pull upon the transverse colon. This produces intense pain. Such pain will disappear at once as soon as the adhesions are divided. In other cases there are strictures in the cæcum or at the ileocæcal valve, secondary to ulcers, for which resection or enteroanastomosis may be necessary.

11. Any abscesses of appendical origin, but situated at a distance from the cæcum, are, of course, to be opened as soon as recognized. This holds good for intraperitoneal collections of pus occurring in the course of a progressive fibrinopurulent peritonitis.

12. Abscesses and suppurations which develop in the peritoneal or retroperitoneal connective tissue should be freely opened by incisions in the front or side of the abdomen, or in the lumbar region. The incision should be drained.

The principles of treatment of diffuse suppurative and septic peritonitis are given on page 174.

Operation during an Acute Attack.—Every operation for appendicitis, whether an abscess is known to be present or not, should be performed aseptically. If removal of the appendix is contemplated, a general anæsthetic should be given. The margins of the infiltrated area are defined and search is made in it for any soft or fluctuating spots. If none such are found, the point where there is greatest tenderness on pressure will usually correspond to the situation of the appendix. It is better to make the incision a little outside of the supposed abscess rather than to make it to the inner side of it. The direction of the incision should correspond to the fibres of the external oblique muscle. In general the incision is similar to the one used for ligation of the iliac artery. An incision 10 cm. (4 inches) in length, the centre of which corresponds to the centre of the abscess, will suffice in most cases. As soon as the skin and deeper fascia have been divided, the œdematous condition of the tissues will be noticed. The fibres of the external oblique may be cut with a knife or separated, exposing the transverse fibres of the internal oblique. These are cut through for a distance of 6 to 8 cm. (2.4 to 3.2 inches) and every cut vessel is ligated. The fibres of the transversalis muscle and fascia are divided and the œdematous layer of thickened peritoneum is exposed.

It is well to remember that it may be adherent to the underlying bowel; therefore it is safer to tear through the peritoneum with forceps. As soon as this is done foul-smelling yellowish or greenish pus mixed perhaps with bits of fecal matter may be evacuated. If the abscess is more deeply placed and covered with adherent loops of intestine and omentum, the safest way to reach it is by following the lateral abdominal wall. When one reaches the cæcum, the abscess will usually be opened. In this manner one may avoid an unnecessary opening of the free peritoneal cavity. The incision in the peritoneum is extended to 6 cm. (2.4 inches) and all pus is wiped away with sterile gauze. The abscess cavity is next explored with the finger for the purpose of finding any accessory cavity. Great care should be taken not to break through adhesions into the free peritoneal cavity. The appendix will usually be found either free in the abscess cavity or easily separable. If not, its position may be known by the direction from which the pus comes, by the position of the fecal concretion, or by changes in the peritoneum, which are most marked in the neighborhood of the appendix.

It is important to disturb as little as possible the cæcum and large intestine. If the appendix cannot be seen, it may be felt as a firm round cord in which the perforation is often palpable.

When the appendix has been found, the surrounding intestines are gently pressed back with retractors, any remains of pus are sponged away, and if the adhesions are broken through at any point, the free peritoneal cavity is protected with a gauze compress over which a blunt retractor is placed. By proceeding in this manner the peritoneal cavity can be protected from infection and the removal of the appendix is facilitated. This organ and its mesentery are often greatly thickened by inflammation, but their isolation is not difficult if the attack is a primary one, since the adhesions will be merely fibrinous. The appendix if partially necrotic is easily broken. When it has been isolated, its mesentery is ligated and cut through. The serous coat of the appendix is next divided about 1.5 cm. (0.75 inch) from the cæcum and pushed back to the cæcum like a cuff. The bared appendix is then ligated close to the cæcum and cut off close to the ligature. Any portion of membrane which projects from this ligature is snipped off with scissors, the stump of the appendix is wiped dry, and the cuff of its serous coat is drawn over it and fastened with a silk suture, if stitches will hold in its tissue. By proceeding in this manner one almost always avoids the formation of a fecal fistula.

If the tissue is too rotten to permit of the treatment above described, simple ligation and excision of the appendix must suffice. If perforation occurs, it is usually delayed for a few days until the wound is protected by granulations; or the stump may be stitched into the incision in the peritoneum so as to protect the peritoneal cavity from feces in case perforation occurs.

The cavity of the abscess is again wiped with dry gauze, which is preferable to wet gauze or irrigation, and a medium-sized drainage-tube is inserted to the stump of the appendix and surrounded by tampons

of iodoform gauze. These tampons should be loose unless there is risk of prolapse of the intestine; in that case they should be packed in firmly.

The avoidance of subsequent hernia in the cicatrix at the operation is worth considering, since this is a trouble which in its simplest form causes the patient a great deal of inconvenience. A ventral hernia is apt to develop if the layers of the abdominal wall, and especially the fascial planes, are not firmly united. It is obvious that the risk of hernia is greatly increased by the use of tampons. When such a wound is left to granulate, muscles and fascia retract so that the cicatrix is formed of connective tissue and skin only. Yet it is desirable, or perhaps necessary, to keep the wound open in order to insure its healing; therefore in cases in which operation has been performed early and the abdominal walls have been found only moderately œdematous, and the quantity of pus has been small, one may sew up at least half of the wound in layers with catgut and silk. Union will ordinarily follow such a suture, although the edges of the wound are contaminated during operation. The tampon in the rest of the wound should be removed early—on the second or third day after operation—and replaced by a smaller one. In two or three days more, if the wound is granulating nicely, it may be closed by deep and superficial sutures except at one small point where a slender drain is left in place. This drain is removed in ten days after operation, and in two weeks the wound will be found firmly united. The patient as a precautionary measure should remain in bed during the third week. If the abscess is very large and has already involved the anterior abdominal wall, the secretion from the wound will be proportionately great and a large tampon necessary. In such circumstances the wound must be left open or stitched only at its ends. Additional stitches may be inserted later when the condition of the wound permits.

When it is necessary to drain the wound for some weeks, the normal layers of the abdominal wall will retract widely. The only method to prevent a hernia in such circumstances is to dissect away the scar-tissue, expose the healthy edges of the muscular and fascial planes, and suture them exactly. It is better not to postpone this second operation too long since every week may add to the strength of the adhesions between the intestine or omentum and the cicatrices of the wound.

The success of radical operation is usually striking. The pains stop at once and the temperature falls quickly to normal. The patient should be kept upon a fluid diet for a few days. No medication is necessary, but for four or five days the bowels should be moved by glycerin suppositories or some similar measure. The patient should be kept in bed until the edges of the wound are firmly united. In uncomplicated cases the patient will be able to go out completely cured in from three to five weeks. But for a much longer period he should avoid any activity which will markedly increase abdominal pressure or lead to stretching of the scar. An abdominal bandage as a prophylactic measure is not recommended.

The abscess may not be confined to the region of the appendix, but may extend upward between the colon and the side of the abdomen, so that a counteropening in the lumbar region may be required for drainage. Indeed, in cases of extensive cellulitis and intense inflammation it may be desirable to prolong the anterior incision transversely into the loin. The treatment of a subphrenic abscess due to appendicitis is spoken of elsewhere.

Abscess in the pelvis may be opened according to its situation by an incision either above or below Poupart's ligament. In such cases the superficial abscess may be a continuation of one in Douglas's pouch, or it may be separated from it by adhesions between the intestine or parietal peritoneum. Examination per rectum will show whether or not there is a second deeper abscess to open. If there is such a deep abscess which cannot readily be reached by separating adherent intestine from the anterior and lateral pelvic walls, it should be opened from below—that is, through the posterior vaginal vault in women and through the anterior wall of the rectum in men and young girls. In other cases the diagnosis may be confirmed by puncture; and if pus is found, the needle will serve as a guide to the instrument with which the abscess is opened—a probe-pointed knife or a pair of curved artery-forceps. In this manner the free peritoneal cavity is saved from contamination with pus and the abscess is opened at its most dependent portion. If an opening is made large enough to admit the finger, no drainage-tube or gauze is necessary. If a deep abscess is opened anteriorly, the use of rubber drains can scarcely be avoided, and the patient should be placed several times daily upon his side, or, still better, upon his face so as to facilitate the escape of pus. In this manner a perfect closure of the abscess cavity is almost certain to be achieved in a few weeks.

Removal of the Appendix in the Interval.—This operation is only to be performed in hospital or where all the facilities for careful aseptic operating are at hand. The patient should be prepared by baths and laxatives and a general anæsthetic should alway be given. Different sorts of incisions are used by different surgeons for the purpose of gaining more space for the operation. The oblique incision above described is sometimes employed, also a median incision and one along the outer border of the rectus muscle. Sonnenberg draws the skin well inward so that the incision through the muscle may later be covered with normal skin. This protection is of doubtful value, especially as hernia rarely follows a properly performed operation.

In order to have a definite direction for the incision, Beck has recommended that it be made in a line drawn from the symphysis pubis to the tip of the eleventh rib. Such an incision will be parallel to Poupart's ligament, and will be situated one-third of the distance from the anterior superior spine to the umbilicus. The incision may well be 12 cm. (4.8 inches) in length. The usual plan is to divide all of the muscular layers in the same direction. It has been suggested

to separate the fibres of the different muscles without cutting any of them, but this method fails to give sufficient room in difficult cases. The peritoneum should be divided with caution because intestine frequently adheres to it. Firm adhesions will be found if an appendical abscess has been previously drained without removal of the appendix. In such a case it is advisable to open the peritoneum to the side of or above the old scar in order to separate the adhesions from within the peritoneal cavity. This may be done by a sharp or blunt dissection.

The appendix can usually be seen or felt. The best guide is the muscular band of the descending colon, for the three bands unite at the point of attachment of the appendix. (P. Müller.) Therefore if one follows the colon to its termination in the cæcum and draws the latter upward, the origin of the appendix will be exposed. If the adhesions are recent or slight, they may be torn through with a piece of gauze or a blunt instrument. The mesentery of the appendix should be ligated in one or more places before it is cut through, as it contains a fair-sized artery. When this has been done, the appendix can be lifted partly out of the wound, and its removal is thereby facilitated. Before the lumen of the appendix is cut into, the surrounding parts should be protected from infection by pads of sterile gauze. A sterile gauze bandage may be used to tampon the surrounding wound. An artery-clamp should be fastened to every tampon so that the latter will not be left in the abdominal cavity.

The serous coat of the appendix should be divided circularly at a distance of 1 to 1.5 cm. (0.4 to 0.6 inch) from the cæcum and pushed back like a cuff. The mucous membrane of the appendix is then ligated with silk close to the cæcum and the appendix is cut through close to this ligature. Care should be taken that its contents do not soil the wound. The stump of the appendix is then cleansed, any surplus of mucous membrane is removed, the stump is buried, and the serosa is closed over it by a double row of fine silk stitches.

If this closure is perfect and the removal of the appendix has been accomplished without tearing apart extensive bleeding surfaces, the parts may be restored to their normal positions and the peritoneum and layers of the abdominal wall sutured with buried catgut and superficial silk stitches. Such a wound should heal primarily and leave no trace of hernia.

If the removal of the appendix is not so satisfactory—for example, if the serous coat is scanty or brittle, so that it cannot be closed over the stump—it may be necessary to cover it with its mesentery or to invaginate it in the cæcum. In such a case the sutured stump must not be dropped back into its normal position, but must be fixed in the peritoneal wound so that if perforation occurs the intestinal contents shall find an easy escape.

If the conditions are as above described, the removal of the appendix is a simple procedure for a skilled operator. Extensive and firm adhesions may make the operation extremely difficult. The appendix may be so buried in cicatricial tissue that it is scarcely to be

recognized, and can only be dissected free with great care and considerable force. One should avoid tearing adherent intestine or stripping off its outer layers. This accident is likely to be followed by a fecal fistula which does not readily heal.

If the appendix is so surrounded by adherent intestinal coils that their injury is likely to follow attempts at its removal, the operation had better be given up. Sometimes the appendix is so closely adherent to the wall of the cæcum that it appears almost a part of it and cannot with safety be separated from it. In such a case the appendix may be split lengthwise and its mucous membrane removed and ligated at its junction with the cæcum and the wound in the appendix sutured. This procedure is very simple and avoids the severe hemorrhage which frequently follows rupture of extensive adhesions.

The operation should always be carried out with the least possible risk to the patient, since operation in the interval is never absolutely necessary. On this account it is better not to close the abdominal wound completely unless the conditions within the abdomen are satisfactory. Otherwise a tampon should be left reaching to the suture-line. This can be removed in five days if it is evident that the suture over the appendicular stump has not given way. Such tamponade is also necessary if there is extensive raw surface or if some focus of suppuration left by the acute attack of appendicitis is discovered. When the tampon is finally removed, the wound in the abdominal wall may be closed by secondary suture.

Removal of the appendix in the interval, if carried out in accordance with these directions, has practically no danger excepting that which accompanies the administration of the anæsthetic.

The patient should remain in bed three weeks in order to give the cicatrix time to become firm. If, in spite of this precaution, the scar shows a tendency to hernia, the patient should wear a well-fitting abdominal bandage.

The directions here given are sufficient for the performance of an appendical operation. At times complications will be found which must be met in accordance with general surgical principles. Space does not permit a detailed description of their treatment.

years of life, while only a few instances are known in which appendicitis has occurred after the fortieth year.

Formerly inflammation of the appendix was widely attributed to some cyst or other foreign body, or to a hidden mass of feces. In many cases of appendicitis the organ is found to contain a small hard mass of feces which has formed in the appendix a true fecal calculus, and has not made its way into it from without. Such a calculus usually has a smooth surface and may reach the size of a hazelnut. The tendency at the present time is perhaps to underestimate the action of such a calculus, especially if its surface is rough. When one considers how a gall-stone which is retained in the small intestine may cause ulceration, it is easy to see that similar results may follow pressure by a fecal calculus within the narrow lumen of the appendix. It is a short step from ulceration to perforation or abscess.

Indiscretion in diet, and especially excesses in the use of alcoholic drinks, may transform a latent appendicitis into an acute attack. Exposure to cold and influenza have also been mentioned as of etiologic importance, but their significance is doubtful. Traumatism, such as a blow or fall, may increase a latent inflammation, but it can scarcely be held responsible for the disease itself.

PATHOLOGICAL ANATOMY.

Inflammation of the appendix may exist in any degree from that of slight catarrh to that of gangrene. In the simplest form of inflammation the mucous membrane is reddened and swollen and its secretion is more abundant than normal. Microscopically there is an infiltration of small round cells in the mucous membrane and in the deeper layers, especially in the submucosa. The follicles are swollen. As a result of these changes the appendix is thickened and somewhat stiffer than normal. It is doubtful whether catarrh of the appendix occurs except under conditions mentioned in the preceding section; at least there must be some obstruction of the secretion by a permanent or temporary narrowing of the lumen. In such circumstances the cavity of the appendix is filled with gray or yellow mucus mixed with fecal matter. In the mucosa small ecchymoses are often seen which lead to a loss of substance of the mucous membrane —the so-called erosions.

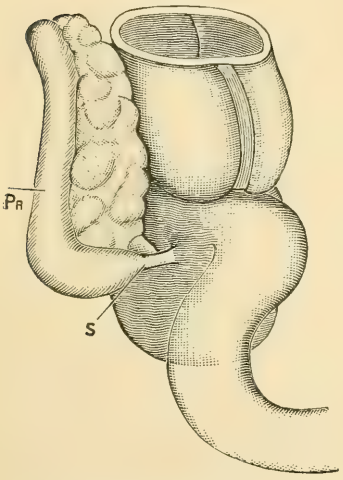
If the obstruction in the appendix subsides and the mucus and bacterial contents can escape into the cæcum, the inflammation may pass over leaving no trace or possibly a little thickening of the appendix. Frequently inflammatory strictures are left which predispose to renewed attacks of inflammation.

If the obstruction is complete, a condition of retention may exist which is known as hydrops of the appendix. Such an occlusion is usually due to cicatricial contraction, but it may also be due to kinking or other peritoneal adhesions. The mucous secretion backs up behind the point of obstruction and distends the appendix to a tense

cylindrical or even spherical body like a retention cyst. Bacterial action is, of course, absent, and the condition may be compared to hydrops of the gall-bladder. The constant pressure within the appendix produces atrophy of the specific elements of the mucous membrane followed by a hypertrophy of the connective tissue. In rare cases such a cyst may become as large as the fist or even larger.

The longer the inflammatory process continues the more likely are the mucous contents to become purulent. The mucous membrane will often become more swollen and redder, hemorrhages will be more numerous, and the erosions more extensive. The infiltration of the wall is more marked, and the muscular coats may hypertrophy in their attempt to evacuate the contents of the appendix. The appendix is as thick as the little finger, and is frequently bent upon itself by adhesions. Such a condition may be spoken of as empyema. (Figs. 90 and 91.) The distention will naturally not be so great as that occurring in hydrops since the internal pressure will cause either necrosis or rupture. Either the whole or a part of the appendix may be the seat of empyema according to the situation of the stricture or strictures.

FIG. 90.



Empyema of the appendix vermiformis: *p.v.*, appendix; *s*, stricture. Mesentery much thickened.

Even though the inflammation of the appendix is of a suppurative character and very extensive, spontaneous recovery is still possible by cicatrization of the ulcers of the mucous membrane with contraction and obliteration of the lumen.

An attack of perforative appendicitis is in counterdistinction to the cases of catarrhal and suppurative appendicitis above described. In any given case it is impossible to say just when perforation will take place. Obviously it is favored by ulceration of the mucous membrane. In many cases of perforation the presence of a fecal concretion suggests that it may have produced the perforation, but in an equal number of cases such concretions are not found. A gradually progressing suppurating thrombosis of the vessels with destruction of tissue may be ascribed to the virulence of the contained bacteria, or to such mechanical causes as the pressure of a fecal concretion, or pus in a tightly distended appendix, or disturbances of circulation the result of a kink. An appendix which is perforated shows if examined soon afterward an intense inflammation. It is very red and swollen. The edges of the perforation are necrotic, black, gray, or greenish, while the adjoining tissues are infiltrated with pus. One or more such perforations may coexist. Sometimes the opening is minute, sometimes it

CHAPTER XVIII.

TUMORS OF THE STOMACH AND INTESTINE.

By Prof. Dr. J. v. MIKULICZ and Dr. W. KAUSCH.

TUMORS OF THE STOMACH.

Tumors of the Stomach other than Carcinoma.—Tumors of the stomach other than carcinoma are rare. The various connective-tissue tumors, such as fibroma, lipoma, fibrolipoma, myoma, and lymph-adenoma, have more pathological than surgical interest since they are usually small and give rise to no symptoms unless they are situated near the pylorus or unless they project in the form of a polyp into the lumen of the stomach. A myoma of the stomach may project into its cavity or grow upward. Such a tumor may become as large as the fist or even larger. It grows slowly and gives rise to few symptoms. It may ulcerate and cause severe hemorrhage. On account of the uncertainty of diagnosis radical operation should be performed even though it seems probable that the tumor is not carcinoma.

Sarcoma constitutes from 5 to 8 per cent. of all primary tumors of the stomach. Metastatic sarcoma in the form of lymphosarcoma or melanosarcoma is commoner than primary sarcoma. It may occur at any age, but from the forty-fifth to the sixtieth year is the usual period. It shows no predilection for the orifices of the stomach. A microscopical examination may be necessary to differentiate between carcinoma and sarcoma. The latter grows usually from the submucous, subserous, or muscular layer. The tumor may be either round-celled, or less often spindle-celled, or very rarely a lymphosarcoma. The average duration of life after the first symptoms of sarcoma are noted is about one year. Sarcoma may reach considerable size. One weighing twelve pounds has been removed. Sarcoma grows more slowly than carcinoma and less often ulcerates, but usually no differential diagnosis can be made until the tumor is exposed. The only treatment is a thorough removal of the growth, which is very likely to recur.

Adenoma occurs in the stomach, and especially in its pyloric portion. There may be a single tumor, or more commonly several. In the latter case they are usually polypoid. A simple adenoma does not extend beyond the submucous tissue. An adenoma may interfere with the functions of the stomach, especially if it is situated near the pylorus. For this reason, and also because of its tendency

to become carcinomatous, it should be thoroughly removed whenever found.

Carcinoma of the Stomach.—Etiology.—Little is known of the etiology of gastric carcinoma. About 7 per cent. of the cases develop in the site of a long-standing ulcer. Many patients refer the origin of carcinoma of the stomach to some injury, usually of a subcutaneous character, but in the majority of cases it is evident that the injury has done no more than to call the attention of the patient to a trouble already existing. In some cases the existing carcinoma seems to be stimulated to more rapid growth by a traumatism. If the question of the relation of a traumatism to a carcinoma has a legal significance, it will be the surgeon's duty to inquire carefully into the nature of the traumatism in order to determine whether it could possibly injure the portion of the stomach which operation or autopsy has shown to be the

FIG. 92.

Carcinoma of the pylorus of the stomach. (Hartmann.)

seat of the new growth. The time which elapsed between the traumatism and the recognition of the carcinoma is also of importance. In most cases one will be obliged to say that the tumor could not possibly have been due to injury. Statistics show that a patient who is not operated upon will ordinarily live a year after carcinoma of the stomach gives well-marked symptoms; that the minimum is a few months and the maximum three years. It is beyond question, however, that carcinoma of the stomach, like carcinoma elsewhere, can exist for a long time without giving rise to symptoms, so that it is unreasonable to sup-

pose that any traumatism less than a year before the death of the patient could be the cause of his carcinoma.

The part which heredity plays in carcinoma of the stomach has been much discussed. While this disease is extremely common (2 per cent. of all deaths, according to Wyss), its frequency varies greatly in different localities. In the tropics, for example, it is very rare. Virchow says that in 35 per cent. of all cases of carcinoma the stomach is affected. Others place the figures at 40 per cent. Men and women are equally affected. Two-thirds of all cases occur between the fortieth and fiftieth years of life, while 10 per cent. occur in the fourth decade, and 2 per cent. in the third decade. Carcinoma of the stomach is almost always primary, and more than one-half of the few cases of secondary carcinoma extend into the stomach from the œsophagus.

FIG. 93.

Fungous carcinoma of pylorus with dilatation of stomach. (Richardson.)

Pathological Anatomy.—The seat of gastric carcinoma is, according to the statistics of autopsies, the pyloric portion in 60 per cent. of the cases, the lesser curvature in 20 per cent., the cardia in 10 per cent., and the rest of the stomach in 10 per cent. (Figs. 92 and 93.) Clinical observation, however, shows that the neoplasm frequently begins in the lesser curvature, perhaps in 40 per cent. of the cases, and gradually extends to the pylorus. At autopsy, when the carcinoma is extensive, it is impossible to say just where it began.

Carcinoma of the stomach is usually divided into cylindrical, medul-

lary, scirrhous, and gelatinous forms. For more complete etiological classification the reader is referred to text-books on pathological anatomy.

The microscopical appearance of a carcinoma varies a good deal. For practical purposes, in the performance of resection it is well to recognize the following four forms:

1. Carcinoma which is sharply differentiated and projects into the lumen of the stomach. It may have a broad base or a narrow base like a polyp. Ulceration is slight. The prognosis in these cases is good, but unfortunately this type of new growth is rare.

2. Carcinoma which is ulcerated throughout almost its whole extent, with a circumscribed elevated margin well marked off from the surrounding tissue and with an infiltrated base.

3. Carcinoma similar to the variety mentioned in the preceding paragraph, except that the border is not well marked but passes gradually into the sound tissue.

4. Diffuse infiltrating carcinoma without definite border.

Carcinoma of the stomach grows both at the edge and in the depth by continuity. It grows most readily in the lymph-spaces and lymph-vessels of the submucosa, hence most carcinomata have a tendency to spread toward the lesser curvature. The relation of the lymphatic stream about the pylorus is such that most carcinomata do not extend far beyond the pylorus. Borrmann states that 31 per cent. pass the pylorus only to a distance of 0.5 to 1 cm. (0.8 to 0.4 inch). This is in sharp contrast to the condition of carcinoma near the cardia, which has a tendency to spread upward and involve the œsophagus for a considerable distance. Furthermore, microscopical examination shows that the real growth of a carcinoma is often several centimetres beyond its apparent growth. Nodules the size of a pea or considerably smaller may be found in the submucous tissue. This fact is of great importance. While it is sufficient in resection to make an incision from 1 to 1.5 cm. (0.4 to 0.6 inch) below the visible edge of the tumor, it is necessary that the incision above the tumor should be from 4 to 8 cm. (1.6 to 3.2 inches) away from its visible margin. This margin of apparently healthy gastric wall which is removed should be greater in case the tumor is of a diffuse, infiltrating type.

Carcinoma of the stomach spreads in four ways: along the lymph-channels, along the bloodvessels, by direct continuity, and by peritoneal metastasis when it has reached the serous surface of the stomach.

1. Extension by the lymph-channels is far the most important for the surgeon, for in operating upon carcinoma of the stomach, as in operating upon carcinoma elsewhere, he must remove affected lymph-glands in order to cure his patient. Recent investigation has thrown much light upon this subject, and no work has been more valuable than that recently done by Most and Cuneo. The illustrations given (Figs. 94 and 95) were drawn by Stahr, who assisted Most in his work.

The lymph-glands which receive the lymph from the whole stomach lie behind this organ along the upper border of the pancreas. They are grouped around the cœliac axis, where they receive the name of cœliac glands. Thence they extend toward the right behind the pylorus and toward the left along the splenic artery almost to the hilus of the spleen, where they are called the pancreaticosplenic glands. These glands receive the lymph from the liver, pancreas, and spleen, as well as that from the stomach. They are connected with the lumbar lymph-glands and their lymph-vessels help to form the intestinal trunks which empty into the thoracic duct.

Before the lymph-vessels of the stomach reach the larger glands along the pancreas they pass through a number of smaller glands which have a certain definite position along both curvatures, especially around the pylorus and in the neighborhood of the cardia. (Fig. 94.)

FIG. 94.

Subserous network of lymph-vessels of the stomach and the first series of lymphatic glands. (Stahr.)

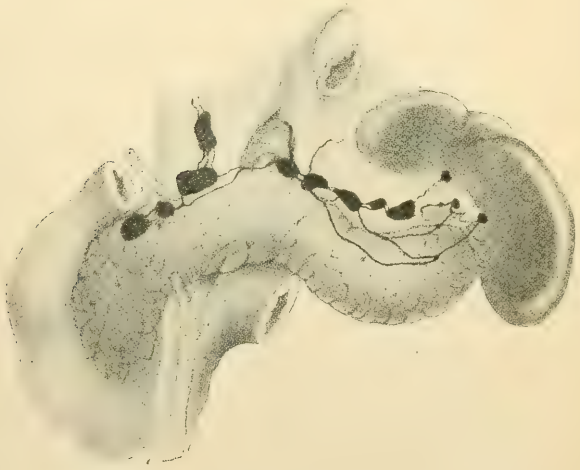
There are three thoroughly distinct lymphatic territories in the stomach in spite of the numerous anastomoses of the subserous and submucous vessels. The greater portion of the anterior and posterior walls of the stomach drain toward the lesser curvature and the cardia. All the glands which are situated around the cardia and along the coronary artery may be called the superior gastric glands. The right half of the greater curvature and a part of the anterior and posterior gastric walls are drained by fewer and smaller lymph-vessels which

connect with glands in the neighborhood of the gastro-epiploic vessels and which are most numerous around the pylorus. These glands are called the anterior gastric glands. The upper half of the greater curvature is drained by vessels which pass toward the spleen. There are a few small lymphatic glands near the spleen, but these lymph-vessels from the stomach are not usually connected with them, but are directly connected with the pancreaticosplenic glands previously referred to.

The number of lymph-glands in these different territories varies within certain limits. Figs. 94 and 95 show in a slightly diagrammatic manner the whole lymphatic system of the stomach.

Some lymph-glands are almost always affected in carcinoma of the stomach even when operation is performed relatively early. If the tumor is situated in or near the lesser curvature, the lymph-glands along the lesser curvature are first affected. If the tumor is of the

FIG. 95.



The larger lymphatic glands between the stomach and pancreas situated along the cœliac axis and the splenic artery. (Stahr.)

pylorus, the lymph-glands lying above the lesser and greater curvatures are apt to be affected. According to Borrmann, there is a continuous carcinomatous growth along the lymphatic vessels up to the affected gland. An escape of cells from the gastric tumor to the gland is an exception. Lengemann, on the other hand, has rarely found a continuous growth along the lymphatic vessels to the affected gland.

The lymphatic current is such that even when the tumor is situated at the pylorus the affected lymph-glands will usually be found along the lesser curvature nearly as high as the cardia. The removal of these glands is not especially difficult. If the deeper pancreatic

glands are involved, their dissection is extremely difficult on account of their position close to or within the pancreas and the proximity of large important vessels and the common bile-duct. Hence if these glands are clearly involved, a radical operation in most cases had better not be attempted. Lymph-glands of the entrance to the liver, and of the retroperitoneal space even as far as the pouch of Douglas, may become affected when the normal lymphatic vessels are obstructed and the flow of the lymph-stream is diverted into other channels. If the carcinoma grows toward the transverse colon, the lymph-glands of the mesocolon may become affected. This is also a counterindication for radical operation.

If the carcinoma extends by the lymph-channels beyond the pancreatic group of glands, it infects glands along the great vessels beneath the diaphragm. When this has taken place, radical operation is naturally out of the question. The cancer-cells may enter the thoracic duct and pass into the innominate vein, and so be scattered throughout the general circulation. At the point where the thoracic duct enters the innominate vein, which is above the left clavicle, there are situated some lymphatic glands whose enlargement is of special importance in connection with carcinoma of the stomach and other abdominal organs. Their enlargement is usually a late symptom, being rarely seen in the early stages of the disease.

The extent to which lymphatic glands are affected does not correspond to the size of the tumor in the stomach, nor must it be assumed that every enlarged lymph-gland is carcinomatous. Perhaps a half of those which are examined microscopically are found free from carcinomatous deposit. It is not surprising to find simple hyperplasia of the lymph-glands, as ulceration is of common occurrence in carcinoma of the stomach. Sometimes the larger glands are carcinomatous, while the smaller are purely inflammatory, and sometimes the reverse is true. Sometimes the nearest glands are carcinomatous, and at other times the carcinoma seems to have missed these while infecting those somewhat more remote. All the lymph-glands which were removed in 9 cases of resection for carcinoma of the stomach were systematically examined. In every case except one some of the glands removed were found to be carcinomatous. These facts show the necessity of the extirpation of all enlarged lymph-glands; or, what is still better, the extirpation of all the tissue in which the lymph-glands are situated as far as this can be done. However, if it is clinically impossible to remove every single gland, one should not give an absolutely unfavorable prognosis since the remaining glands may perhaps be enlarged by inflammation and not carcinomatous.

2. Carcinoma of the stomach may spread through the bloodvessels, namely, the veins of the stomach, the portal vein, etc.

3. Extension may take place by direct growth into a neighboring organ; for example, the liver, pancreas, colon, or abdominal wall.

4. A fourth method of extension is by metastases throughout the peritoneal cavity which occur when a carcinoma breaks through the

serous coat of the stomach. The motions of the abdominal organs then distribute fragments of the tumor far and wide. These peritoneal metastases appear as minute or larger pearly nodules which are often accompanied with a greater or less amount of free fluid. The prognosis is, of course, unfavorable.

Sooner or later carcinoma of the stomach undergoes ulceration. In many cases it is difficult to say whether the ulcer produces the cancer or the cancer the ulcer. The only definite way to prove that a carcinoma has developed in an old ulcer is to show that only a portion of the ulcer or cicatrix is carcinomatous in character. The ulceration which accompanies carcinoma may erode a bloodvessel and produce hemorrhage. Septic thrombosis may also follow carcinomatous ulceration; and it does so, indeed, more frequently than it follows simple ulceration. As a result of this the emboli may lodge in the liver, spleen, etc., or an abscess or cellulitis of the wall of the stomach may result. Carcinoma of the stomach may lead to perforation and circumscribed or diffuse peritonitis. In rare instances a fistula is set up between the stomach and intestine, or the stomach and the external world.

The portion of the wall of the stomach which is not directly involved in carcinoma suffers at an early period from catarrhal and other changes and later atrophies. On account of these changes functional disturbances of the stomach are produced, such as the absence of hydrochloric acid, diminution of ferments, the presence of lactic acid, and motor insufficiency.

Symptoms.—If a carcinoma of the stomach is situated near the cardiac or pyloric orifice, the narrowing of the lumen which it produces brings about rapid emaciation and loss of fluid in the patient's body. This is the result not of the carcinoma, but of the stenosis, since it also occurs with stenosis of benign origin. If the carcinoma is so situated that it does not obstruct either orifice, the patient's nutrition is slowly affected as a result of the dyspepsia. At a later period a characteristic cachexia of cancer manifests itself and the patient becomes much emaciated and highly anæmic. The skin is yellowish gray. The mucous membranes are pale or yellowish and there is œdema especially of the feet and legs. The quantity of hæmoglobin in the bloodvessels falls to 40 per cent., or 30 per cent., or even as low as 15 per cent. of normal. If there are emaciation and loss of fluid in the body as a result of mechanical obstruction to nutrition, the percentage of hæmoglobin may equal or even exceed the normal. The cachexia of gastric carcinoma is not of itself a counterindication for radical operation since patients in whom it has existed at operation have been permanently cured of their trouble.

A patient who is suffering from carcinoma of the stomach should, of course, be examined with reference to disease elsewhere. Metastases in the liver may be palpable or their presence may be shown by jaundice or obstruction to the portal circulation. There may be ascites, or metastases in the peritoneum or abdominal lymph-glands.

The lymph-glands in other portions of the body should be examined, and a rectal and vaginal examination should not be omitted. The leucocytosis of normal digestion is usually wanting, but this is by no means pathognomonic of carcinoma; neither are the ascitic symptoms. The tongue is usually coated, the appetite poor, and the patient complains of eructations of gas, bad taste in the mouth, and heartburn. Pain may or may not be present, but is rarely so severe as in gastric ulcer. Constipation is the rule, or constipation alternating with diarrhœa.

Carcinoma which is situated near the pylorus soon interferes with the motor action of the stomach. This result may also follow development of the carcinoma in other portions of the stomach by reason of the infiltration of the muscular wall. There are instances, however, in which the motor action of the stomach is increased in the presence of a carcinoma. It is characteristic of carcinoma of the stomach that the mucous membrane suffers early from catarrh and becomes atrophic. Free hydrochloric acid and ferments diminish or disappear altogether. Bacteria, especially the bacteria of lactic acid fermentation, are normally held in check by the hydrochloric acid. When the secretion of this acid is much diminished, these bacteria multiply. The growth of these bacteria and those of butyric and acetic acid fermentation is favored by motor insufficiency, but they may also be present even though the motor action of the stomach is normal. If a carcinoma develops in the scar of an old ulcer, the secretion of hydrochloric acid even in an advanced stage of the disease may be normal. Under such circumstances lactic acid fermentation is absent. Lactic acid fermentation may appear in severe catarrhal conditions, or atrophy of the mucous membrane with an absence of hydrochloric acid, but it is on the whole rarely found excepting in connection with carcinoma. So that whenever it is present the question of carcinoma must be carefully considered even though there is no tumor or other evidence of cancer. Unfortunately the development of lactic acid is a late symptom. When it occurs, the tumor is usually well developed, and the inability of the surgeon to palpate it is due to its situation in the posterior wall of the stomach or in the lesser curvature where it is hidden by the ribs.

While repeated hemorrhage is the rule in ulcerating carcinoma of the stomach, the quantity of blood lost at one time is rarely large. Microscopical examination of the vomitus will, however, almost invariably show the presence of at least a few red blood-corpuscles.

The demonstration of a palpable tumor in a patient whose symptoms are of the character above described is most significant. All the other symptoms mentioned may exist without carcinoma or other tumor of the stomach. Furthermore, they may be wanting although carcinoma is present.

The size of the tumor may vary from that of a pigeon's egg to that of the two fists. Its shape is equally variable. A small tumor of the pyloric region feels round and sharply differentiated. If the

lesser curvature is also involved, the hard round mass will seem to extend upward and to the left in the form of a crescent. A tumor of the lesser curvature if it can be palpated at all, will seem to have a semicircular shape or the shape of a kidney. A tumor of the posterior wall of the stomach is either not palpable or else it gives a feeling of indistinct resistance. Tumors of the cardia and fundus are out of the reach of the examining fingers unless they are very large, when they may sink below the costal margin with deep inspiration.

The surface of a palpable gastric carcinoma is for the most part smooth. If the tumor feels nodular, it is usually the result of inflammation of the lymph-glands of the lesser curvature and gastrocolic ligament. If the abdominal wall is flabby and relaxed, the palpating fingers can usually recognize that the tumor is very hard, almost like cartilage. A dull percussion-note will be obtained only if the tumor is large. Pressure upon the tumor is not usually painful, and in no case is there such gastric sensitiveness as almost always exists with simple ulcer. The results of palpation vary with the condition of the abdominal wall. If this is much emaciated and relaxed, as in women who have borne many children, the outline of the tumor can be clearly felt and a chain of infected glands may perhaps be made out. If the abdominal walls are firm and thick, one can make out little more than the presence of a tumor.

The results of palpation are so uncertain that in many cases this method of examination alone is not sufficient to establish the diagnosis of carcinoma. The peculiarities of the tumor, its origin and its localization in the abdomen, are questions which must always be considered. Moreover, in most cases a palpable tumor is not an early symptom; but for that matter, the other symptoms of carcinoma rarely develop in the characteristic way early in the disease.

Diagnosis.—Carcinoma of the stomach presents various clinical pictures which may be classified in three groups: 1. Carcinoma without stenosis; 2. Carcinoma of the cardia; 3. Carcinoma of the pylorus.

1. Carcinoma of the stomach without stenosis is usually situated in the lesser curvature, rarely in the fundus. However, a cardiac carcinoma may grow to considerable size without producing symptoms of obstruction. To a less degree this is true of carcinoma of the pylorus. Obstruction is due not merely to narrowing of the orifice, but also to weakening of the muscles, a symptom that is very noticeable in the later stages of the disease on account of the atrophy of the stomach-wall. Carcinoma without stenosis produces a variety of dyspeptic symptoms, and within a short time well-marked gastric catarrh. There may or may not be vomiting, and in early vomiting there may be no blood. Even at a later period the quantity of blood is small. Free hydrochloric acid disappears and lactic acid soon appears. Motor disturbance is at first slight or absent. Whether a tumor can

be felt depends not only upon its size, but more upon its situation in the anterior wall, lesser curvature, posterior wall, or fundus. In some cases death occurs without a tumor being palpable. The patient gradually loses flesh and strength. He usually seeks professional advice on account of the obstinate gastric catarrh, or on account of loss of flesh, or because he has noticed a tumor.

When no tumor can be found, differential diagnosis rests between carcinoma, gastritis, atrophy, and in rare cases chronic ulcer with anæmia. If a tumor can be felt, the diagnosis rests between carcinoma, ulcer, or a scar, or a chronic perigastritis due to ulcer. One must also consider tumor of the neighboring organs, such as the liver, pancreas, colon, gall-bladder, and omentum. The duration of the disease from the first symptoms until death varies between several months and several years, the average duration of life being one year.

Sometimes death occurs as a result of inanition. Less frequently metastases in the liver or elsewhere are the direct cause of death. In many cases some other disease, such as pneumonia, develops and terminates life.

2. A carcinoma of the cardia or of the cardiac portion of the stomach gives the same symptoms as cancer of the œsophagus as soon as the orifice is encroached upon. This does not happen in most cases until late in the disease; indeed, there are many instances in which food or a stomach-tube passes the cardia without difficulty, although an extensive tumor exists, the lumen being preserved by ulceration. In such a case the tumor which is situated beneath the ribs cannot be felt, so the diagnosis is particularly difficult. Other symptoms which may be present are pain produced by pressure upon the ensiform cartilage, and retardation or absence of the second gurgle due to swelling. Normally there is an interval of twelve seconds between the first and second gurgle.

3. As soon as carcinoma of the pylorus produces stenosis the symptoms of mechanical insufficiency arise. There is fermentation of the vomited material (usually butyric acid fermentation), which contains no free hydrochloric acid, but free lactic acid. In exceptional cases hydrochloric acid is present and lactic acid absent. The patient loses weight rapidly and there is marked decrease in the fluids of the body—a condition, in other words, of inanition. Usually a tumor is palpable early if its seat is in the pylorus. If the carcinoma starts in the lesser curvature and then extends to the pylorus, the tumor is not palpable until it has reached a considerable size. In such a case stenosis will be a later symptom, so that cachexia will rarely be wanting at the time that symptoms of inanition are present. Patients suffering from pyloric carcinoma seek medical advice relatively early because the pyloric obstruction shows that there is some serious trouble with the stomach.

Differential diagnosis must include the consideration of stenosis from other causes, such as ulcer, kinking, perigastritis, tumors, etc., of the stomach, and also atonic insufficiency whether a tumor is pal-

pable or not. The course of the disease and the chemical examination of the gastric contents are frequently of the greatest importance in making a diagnosis; still one should remember that ulcers which have existed for several years, or scars of old ulcers, may become the seat of a carcinoma.

Carcinoma which is situated in the pylorus or near it, unless treated surgically, leads speedily to death from inanition.

Treatment.—The only successful treatment of carcinoma of the stomach is radical removal of the new growth. In other portions of the body, for instance, in the breast, carcinoma may undergo a spontaneous recovery or contraction of the connective tissue, or it may remain in such a quiet state that the life of the individual is not threatened for a long time. In the case of carcinoma of the stomach such cicatricial and contractile changes will only hasten death from inanition. Washing out of the stomach and the administration of internal remedies are only capable of partially relieving the symptoms, and have no effect upon the progress of the disease.

Operations performed for carcinoma of the stomach may be either radical or operative. If it is possible to remove the tumor together with infected lymph-glands, the indication for operation is absolute. Unfortunately this can only be known after the abdomen is opened. Many tumors which are small and freely movable give the impression that a radical operation is feasible; but when the abdomen is opened, it may be seen that there are extensively involved lymph-glands or metastatic nodules in the peritoneum or liver. In other cases exploratory laparotomy shows that a much larger tumor has not produced metastasis, and hence offers a choice of radical cure. Therefore exploratory laparotomy should be performed in every case unless radical operation is clearly impossible. Absolute counterindications for operation are extensive enlargement of lymph-glands in the neighborhood or elsewhere, metastases in the liver or other organs, and ascites. The strength of the patient is also to be considered. Thus well-marked cachexia is an unfavorable condition for an extensive operation.

The conditions of other organs which counterindicate radical operation are: chronic bronchitis or tuberculosis, or other serious diseases of the lungs, nephritis, or diabetes of well-marked degree. Cachexia, if not extreme, is of itself a counterindication. Mikulicz has operated and obtained permanent cure in cases of cachexia in which the hæmoglobin was only 20 per cent. of the normal.

In most cases a complete diagnosis cannot be made until the abdomen is opened, therefore the first incision should be small and situated in the epigastrium or mesogastrium according to the position of the tumor. Whether a radical operation is to be performed, cannot be decided from the size of the tumor alone since removal of the whole stomach is not technically impractical. If the œsophagus and duodenum cannot be united, the jejunum may be utilized for the anastomosis. However, in most cases in which the whole stomach is involved by the tumor metastases in the lymph-glands or elsewhere will make a

radical operation useless. According to Herczel, the stomach has seventeen times been removed with success, but the date of these operations is too recent to permit one to say what the practical results will be.

If the tumor does not require removal of the whole stomach, resection is preferable to extirpation of the organ because it carries with it less risk, and even a small portion of the gastric wall will dilate and be of great benefit to a patient as a reservoir for food.

The upper incision should be made at a distance of 4, 6, or 8 cm. (1.6, 2.4, or 3.2 inches) from the visible margin of the tumor. (Page 444.) The greater distance is chosen in case of infiltrating cancer. Indeed in such a cancer total extirpation may be preferable to resection because the involvement of the stomach-wall is often far greater than it appears to the naked eye. The lower incision needs to be removed from the margin of the tumor only 1 to 1.5 cm. (0.4 to 0.6 inch).

If the tumor is adherent to the transverse colon, a portion of the latter should be resected. Such resection is also necessary if removal or division of the mesocolon is necessary. Such an extensive operation is rarely advisable, not because of its technical difficulty, but because the chance for radical cure under such circumstances is so slight. If such a condition is recognized before radical operation is begun, the surgeon will do well to confine himself to palliative measures. (Page 383.)

Involvement of the liver is a counterindication for a radical operation, not because of fatal hemorrhage, the fear of which previously kept surgeons from operating upon the liver, but because the chance of radical cure under such circumstances is practically *nil*. Adhesions between the stomach and liver due to an old ulcer do not counterindicate operation. If a small portion of the pancreas is involved, it may be removed without danger. The removal of larger portions is inadvisable on account of the risk of hemorrhage and certain physiological after-effects (diabetes). Adhesions with the spleen are rare and are no counterindication for operation except as they show that the disease is already widespread.

In every case of gastric carcinoma few or many lymph-glands will be found involved. This involvement is so universal that its absence throws doubt upon the diagnosis of carcinoma. The presence of enlarged glands is not absolute proof of cancer since glands are enlarged in connection with ulcer. In doubtful cases such glands should be examined at the time of operation, but a negative result of such examination carries little weight.

Swollen lymph-glands of both curvatures do not make radical operation impossible. Even if the tumor is small, it is better to remove all the glands as far as the cardia. This is best done by removal of the portion of the smaller omentum in which they are situated. Mikulicz performs resection as follows: The lower omentum is separated from the stomach at the point where the latter is to be resected. The branches of the coronary artery are caught with clamps and then

ligated close to the stomach and divided between the clamps and ligatures. The cardiac portion of the lesser omentum is surrounded by a strong mass-ligature and the pyloric portion is clamped. It is divided between the ligature and the clamp. Then as the vessels are clamped and tied the lesser omentum is separated from the stomach still farther toward the cardia, and this can be carried out step by step until the cardia is reached. The lesser omentum is then tied as high up as possible and the stump cut away. This method of operating permits the certain ligation of the posterior branches of the coronary artery and the first provisional mass-ligature serves as a traction thread to draw down the lesser omentum and bring into view a portion of it which is otherwise inaccessible.

Pancreatic lymph-glands present greater difficulties on account of their deep situation in the pancreas. Frequently it is necessary to remove with them a portion of the pancreatic tissue. If enlarged glands are situated close to important vessels around the portal vein or in the retroperitoneal tissue, radical operation is impossible. Ascites of a mild degree is not an absolute counterindication if there are no visible carcinomatous nodules in the peritoneum.

If there exists a pyloric carcinoma with stenosis whose removal is technically possible, while the condition of the patient is bad, ought one to perform a radical operation or first to improve the condition of the patient by gastro-enterostomy and then to perform radical operation at a later date? This latter plan has been variously recommended, but has proved inadvisable. Sometimes the patient, finding his condition improved, will refuse further operation until the favorable time has gone by. Sometimes the adhesions which follow the first operation render the second one more difficult than it otherwise would have been. If the operator discovers during operation that he can remove the tumor itself, but cannot remove all affected glands, ought this to be done or should gastro-enterostomy be performed? Lengemann has found that not all enlarged lymph-glands in cases of carcinoma are carcinomatous, so that radical cure is not impossible even though some enlarged glands are left behind. Furthermore, with the present technic resection of the stomach is only slightly more serious an operation than gastro-enterostomy. Its mortality has been 25 per cent. as compared with 26.5 per cent. mortality for gastro-enterostomy when performed for carcinoma in Mikulicz's clinic in the last few years. Furthermore, a patient who recovers from resection lives longer and in more comfort than a patient upon whom gastro-enterostomy is performed; at least he is not likely to suffer from local recurrence in the stomach, while a patient after gastro-enterostomy is freed from his gastric symptoms for only a short time, perhaps not at all. Therefore one must admit that resection of the stomach when it is technically advisable is the best palliative operation for gastric cancer.

If resection is not practicable, four palliative operations must be considered, namely, gastro-enterostomy, gastrostomy, elimination of the pylorus, and jejunostomy.

Gastro-enterostomy is indicated with severe motor insufficiency of the stomach if the carcinoma is not so extensive that a speedy death is to be expected. Simple anhydræmia (dryness of the body) is no counterindication for the operation if the hæmoglobin of the blood is relatively abundant. Advanced anæmia and cachexia are counterindications. (See page 293.) Gastro-enterostomy may restore the motor function of the stomach, free the patient from vomiting, and relieve him from inanition. The point chosen for anastomosis should be at least 5 cm. (2 inches) distant from the tumor. If the tumor is situated so high up that anastomosis cannot be made above it, the abdomen should be closed without further operation. If the tumor is so placed that stenosis does not and is not likely to occur, there is no object in performing gastro-enterostomy.

Gastrostomy need only be considered in case of cancer of the cardia or cardiac portion with stenosis.

Jejunostomy is recommended by Maydl for gastric cancer in all cases in which radical operation cannot be performed. The objections to this plan of treatment are stated on page 455.

Elimination of the pylorus may be serviceable if a gangrenous carcinoma is situated at or near the pylorus.

For the technic of operation see page 478.

Results of Operation.—Statistics of resection of the stomach for cancer are particularly unsatisfactory. One surgeon operates upon patients whom another surgeon would consider to be in an inoperable condition. One surgeon operates thoroughly, and the immediate results of operation will therefore not be so good as those of another who makes a less extensive removal. Six years ago Mikulicz began to remove most thoroughly the lymph-glands in every case of resection for carcinoma. The mortality of his operations rose, and has only come down as he has become more familiar with the new technic. Resection of the tumor alone is a simple procedure, while removal of all affected lymph-glands is relatively difficult. In time deaths from technical imperfections, resulting in perforation, peritonitis, gangrene of the colon, etc., will doubtless become fewer and fewer as the surgeon's technic improves. Pneumonia, collapse, and embolism will occasionally follow in severe abdominal operations. In the earlier years mortality was more than 50 per cent., whereas in the last few years the mortality of several operators has fallen to less than 30 per cent. In Mikulicz's clinic up to the year 1898 there were 56 resections of the stomach, 26 of which were followed by death within thirty days, equal to a mortality of 46.5 per cent. Since the year 1898, 44 resections have a mortality of only 25 per cent. Unfortunately the permanent results of operation are less satisfactory. The exact percentage of cures is ascertained with difficulty. Mikulicz has definite reports from 58 patients who recovered from operation; 20 of these were living at the time of report from six months to eight and a quarter years after operation, 17 of them having survived a year or more, 10 more than two years, 4 more than three and a half years. As no one of these 4 shows a sign of recurrence,

they may be considered radically cured. These 4 were part of a group of 23 patients operated upon more than three and a half years previously. Estimated in this manner the percentage of radical cures is 17. Thirty-eight patients died of recurrence at periods varying from two and a half to forty-seven months; 7 of them lived more than two years after operation, 9 more than one and a half years, and 6 more than one year. The average duration of life was over sixteen months.

Unsatisfactory as these results are, they are not bad enough to make one ready to give up resection for cancer of the stomach. As stated above, a few patients are permanently cured, while the life of others is prolonged from one to four years in relatively good health. When one compares these results with the absolute failure of internal treatment, the usefulness of operation is obvious. One sees further that the results of operation upon cancer of the stomach are not so much worse than those of operation upon cancer elsewhere in the body, the surgical treatment of which is everywhere recognized as justifiable. Thus the permanent results of operative treatment of cancer of the tongue and rectum are scarcely better than those of cancer of the stomach. Cancer of the breast and uterus is much more favorably situated for radical removal, but the better results obtained are only of recent years after the technic was much improved. It is reasonable to suppose that further experience will lead to better results after operation upon carcinomatous stomachs.

The condition of the patient who recovers from operation is in most cases satisfactory. Some patients suffer from dyspeptic symptoms of a mild degree, a result of the gastritis which accompanied the cancer. If the hydrochloric acid is deficient, taste for meat may be wanting. Under such circumstances anæmia is apt to persist even though recurrence of the cancer does not take place. Usually there is a prompt increase in weight, sometimes as much as fifty pounds.

The motor action of the stomach is often restored completely. Sometimes it exceeds the normal, although the opposite has been stated by other writers. Usually lactic acid fermentation disappears as the motor function improves, although it may exist in a lessened degree for a long time. In a few cases free hydrochloric acid reappears in the stomach, although it was absent before operation.

If recurrence takes place, the symptoms thereby caused will vary according to whether it is a local or a metastatic recurrence.

Although gastro-enterostomy is a far simpler operation than resection, its mortality in the case of cancer is not much better than that of resection. This is doubtless due to the fact that resection is usually performed in favorable cases and gastro-enterostomy in severe cases in which ulcerating tumors are left behind to set up hemorrhage, perforation, etc. The causes of death are the same whether resection or gastro-enterostomy is performed with general or local anæsthesia.

The duration of life after recovery from gastro-enterostomy varies greatly, but it is considerably less than after recovery from resection.

Still cases have been reported in which patients lived four years or more. Such statistics should not be accepted without question unless the diagnosis has been made by microscopical examination of lymph-glands removed at operation or by autopsy. Mikulicz reports 67 cases in which the patients survived gastro-enterostomy more than a month. Two of them lived more than two years (twenty-seven and twenty-six months), 10 more than one year, 11 more than six months, and the remaining 44 less than six months. The average duration of life was therefore six and four-tenths months.

The condition of the patient after gastro-enterostomy is often such that one cannot speak either of temporary cure or marked improvement. In view of the considerable number of patients who die within a few days after operation and the still greater number who live only a few weeks, one must conclude that gastro-enterostomy for cancer of the stomach is an operation of little value and one which is likely to be performed less and less often.

TUMORS OF THE INTESTINE.

Benign Tumors of the Intestine.—Benign tumors of the intestine are uncommon. The forms which are found are adenoma, lipoma, fibroma, myoma, myxoma, angioma, teratoma, and such combinations of benign and benignant neoplasms as myosarcoma, fibrosarcoma, etc.

Adenomata spring from the glands of Lieberkühn and simulate their structure. They may be pedicled or sessile, solitary or multiple. They are small or as large as the fist. While commoner in early youth, adenomata may be found at any age. Multiple polypoid adenomata are sometimes found scattered throughout the large intestine, especially in the neighborhood of the ileocæcal valve.

Small uncomplicated adenomata give no symptoms and possess only pathological interest. They may lead to important complications, especially invagination. The polyp is pulled upon by the peristaltic action of the bowel below and drags downward with it the mucous membrane to which it is attached. There is first a lateral intussusception which ultimately becomes circular. Adenoma is also of importance since it may represent a step in the development of carcinoma.

If the adenoma is large, it may produce the symptoms common to all large tumors of the intestine which are described on page 392. Heurtaux mentions 2 cases of adenoma of the ascending colon which produced invagination and death. Port mentions 13 cases of multiple polypoid adenomata: 2 of these patients died from invagination, 2 from hemorrhage, and 5 from carcinoma, which developed in some portion of the adenomatous bowel.

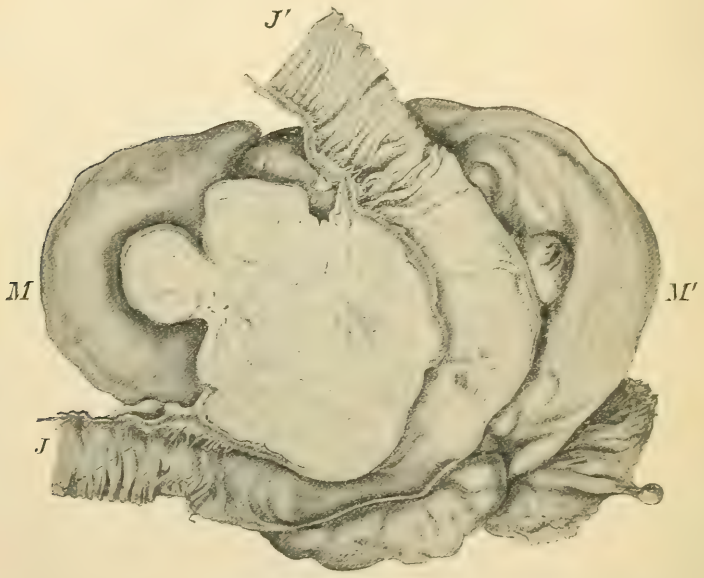
Single adenoma, if treated at all, should be removed. If invagination has taken place, this will require the first treatment. Multiple adenomata are scarcely amenable to radical operation, but they may be treated by the establishment of an artificial anus.

Lipomata of the intestine vary in size between that of a hazelnut

and the fist, in the 18 cases collected by Hiller. These tumors may occur in the stomach, small intestine, or large intestine. They usually grow from the submucosa and may be sessile or polypoid in shape. Invagination of the intestine occurred in 9 of the 22 cases referred to. This is especially likely to happen if the lipoma involves the small intestine.

Myoma of the intestine is perhaps rather more frequent than lipoma. (Fig. 96.) Steiner collected reports of 58 cases of myoma of the stomach or intestine, in one-half of which the tumor was first discovered at autopsy. The patients affected were of all ages and of both sexes.

FIG. 96.



Myoma of intestine: *M*, *M'*, the tumor, a part of which is cut across to show its loose attachment to the intestine, *J*, *J'*. (Steiner.)

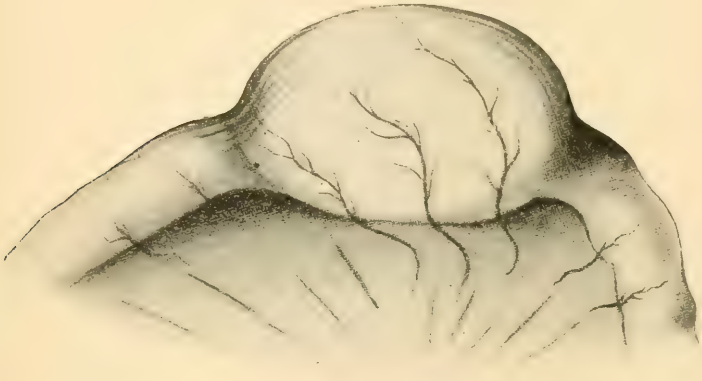
The myoma develops from the muscular layer, and may grow inward or outward and become therefore either submucous or subserous. In 21 of Steiner's cases the tumor was situated in the stomach, in 16 in the small intestine, and in 14 in the large intestine and rectum. There were 27 cases in which the tumor projected into the lumen, and 24 in which it was subserous.

As a rule a submucous myoma does not reach the size of a subserous one. The smaller tumors are smooth, the larger usually nodular. In rare instances the inner surface of the tumor has been found to be ulcerated. Since a myoma may occur in any portion of the circumference of the intestine, it is sometimes found at the junction of the mesentery growing between the mesenteric layers and simulating

the true tumor of the mesentery. In 4 cases subserous myomata were multiple.

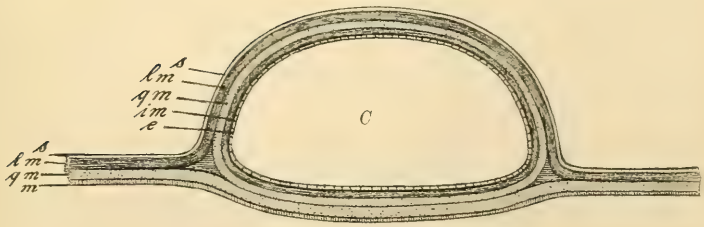
An internal myoma may lead to stenosis or invagination. This complication rarely occurs with an external tumor. The latter, if large, may drag the intestine from its proper situation and press upon other abdominal organs. Any myoma may change into a sarcoma. A small internal tumor may produce no symptoms, or may give rise to the symptoms of chronic intestinal stenosis. If the tumor is pedicled,

FIG. 97.



Cyst of the small intestine.

FIG. 98.



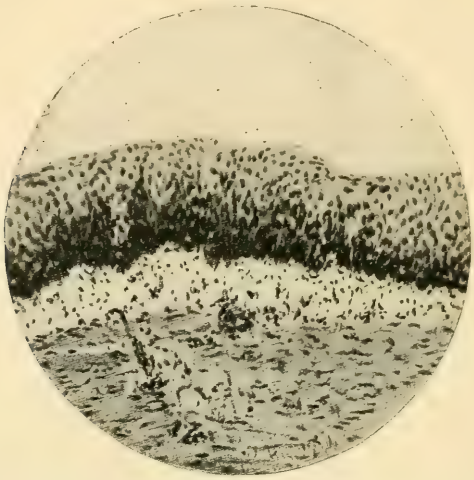
Section of cyst and intestine: *s*, serosa; *lm*, longitudinal muscle; *qm*, transverse muscle; *im*, wall of cyst; *e*, lining of cyst; *m*, mucosa.

there may be intervals in which the patient is wholly free from symptoms. The tumor may lead to intussusception, especially if it is pedicled. Rarer complications are hemorrhage and gangrene, the results of ulceration. The first symptoms of external myoma are those of a gradually developing palpable tumor which does not interfere with the passage of feces until it reaches a considerable size. Even then it rarely produces complete obstruction. It may set up adhesions and thus produce a kink of the intestine. An exact diagnosis of myoma can hardly be made before operation. The most that one can hope to say is that a benign tumor of the intestine exists.

The symptoms of intestinal myoma, the course of the disease, and its outcome vary greatly, as indicated above.

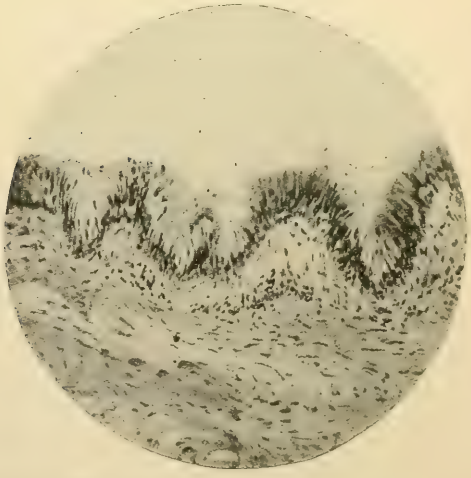
Sometimes a tumor will exist for twenty years. If it is pedicled and projects into the lumen of the bowel, it may be torn away and thus a spontaneous cure result. This happened twice in 7 cases in

FIG. 99.



Stratified epithelium with which the greater part of the cyst was lined.

FIG. 100.



Tall cylindrical epithelium which formed the lining of the cyst in places.

which expectant treatment was followed; the other 5 patients died of hemorrhage, sepsis, or invagination. In general, external myoma is less dangerous than internal, but even then the presence of a constantly growing tumor gives an unfavorable prognosis.

The treatment of external myoma, like that of lipoma, is merely operative. Even though no complications exist, the impossibility of excluding the diagnosis of malignant tumor makes operation imperative. If the tumor is known to have existed a long time and increases very slowly, the indication for operation is less urgent.

If invagination, stenosis, or other complication arises, the treatment is such as is rendered necessary by such a condition.

The operation should in most cases include the radical removal of the tumor. If the myoma is subserous, it may be shelled out without opening the bowel. If the tumor projects into the lumen of the bowel, it will usually be necessary to excise a portion of the whole wall, or to perform circular resection. In cases in which an extensive operation is not advisable entero-anastomosis, or elimination of intestine, or artificial anus must be considered. Heurtaux gives reports of 16 operations, with 14 recoveries and 2 deaths.

Fibromyoma and fibromata and cysts of the intestine (Figs. 96–100) are very rare tumors.

A few cases have been reported of cysts of the intestine containing gas. Their origin is not well understood. A similar trouble occurs rather more frequently in swine.

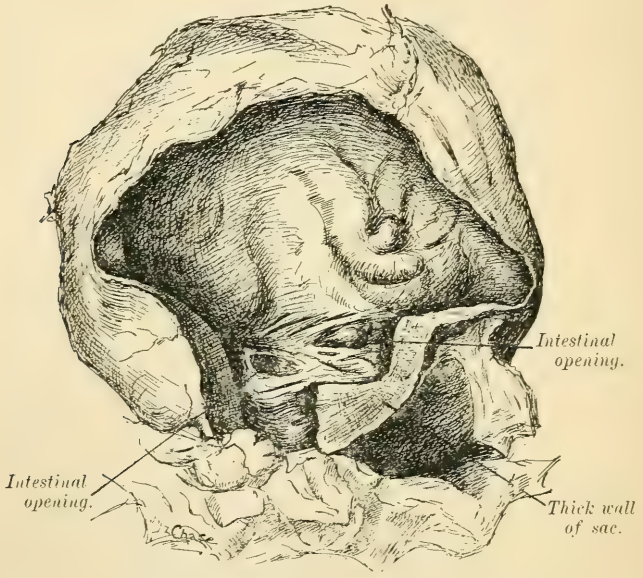
Sarcoma of the Intestine.—Sarcoma of the intestine is rarer than carcinoma. The relation of these two tumors is about as 1 to 20. Sarcoma may involve either the small intestine or the large intestine or rectum, while carcinoma is far more frequently found in the large intestine and rectum. Kruger-Boas, who collected reports of 37 cases of sarcoma of the intestine, found the small intestine involved 16 times, the ileocæcum once, the cæcum twice, the vermiform appendix once, the transverse colon once, both the small and large intestine once, and the rectum 16 times. Smoler reckons 1 case of sarcoma of the small intestine for every thousand autopsies.

Sarcoma of the intestine may occur at any age, but most frequently between the thirtieth and fortieth years. Most of the cases reported have been in females. In Siegel's collection of 34 cases 19 of the tumors were round-cell and 5 spindle-cell. The other tumors were alveolar or melanotic, cystosarcoma, lymphosarcoma, myxosarcoma, and endothelioma. Tuberculosis and sarcoma may coexist. Usually an intestinal sarcoma begins in the submucosa.

Sarcoma of the intestine may reach a considerable size. In counter-distinction to carcinoma, it involves a considerable extent of the bowel and is much more likely to grow into the neighboring organs, especially the mesentery and omentum. Hence it is not always possible to say in which organ it began. It also sets up metastases in the liver, kidney, spleen, and retroperitoneal glands. In another respect sarcoma of the intestine differs from carcinoma. Several writers have called attention to the absence of stenosis with sarcoma, and indeed the lumen of the affected bowel may be considerably increased. There are, however, instances in which sarcoma has produced stenosis of a high degree. Siegel asserts that symptoms of stenosis occur in about one-half of the cases.

Symptoms.—The symptoms of sarcoma of the small intestine vary greatly. There is often a palpable tumor which for a time is freely movable. There are rapid loss of flesh and development of cachexia, as the tumor grows much faster than carcinoma. Ascites and metastatic tumors are frequent complications. The life of the patient rarely continues more than one year.

FIG. 101.



Sarcoma of intestine producing dilatation.

Diagnosis.—Sarcoma of the intestine has to be differentiated from other intestinal tumors, and especially from carcinoma. Such a differential diagnosis is only possible in the case of a rapidly growing tumor which does not produce stenosis. In most cases nothing more definite than a probable diagnosis can be made until the abdomen has been opened, and even then a microscopical examination may be necessary to determine the nature of the tumor.

Treatment.—Treatment is purely operative, and is the same as the treatment of carcinoma of the intestine. Thus far the results of operation have not been satisfactory. Almost all the patients were seen too late to expect the best results from radical treatment. Still in a few instances the surgeon has succeeded in removing the tumor so completely that the patient was permanently cured.

Carcinoma of the Intestine.—Carcinoma of the large intestine is much more common than that of the small intestine. The rectum is the favorite seat of this disease. Of 100 cases of carcinomata situated above the rectum, in 5 instances the tumor was in the small intestine, in 19 in the cæcum, in 39 in the colon above the sigmoid flexure, in

31 in the sigmoid flexure itself, while in 6 cases the seat of the trouble was not exactly stated. Other statistics are in substantial accord with these. In nearly one-half of all cases of carcinomata occurring in the alimentary tract below the stomach, the tumor involves the rectum. For the sake of comparison, Hiemann's collection of statistics from the Prussian hospitals in the years 1895 and 1896 are given. He found 20,544 cases of cancer, in 10,537 of which the alimentary canal was involved as follows: tongue, 269 times; mouth and throat, 192; œsophagus, 1011; stomach, 4288; intestine, 1706 times. The small intestine was involved 20 times, the large intestine 224 times, and the rectum 1204 times; while in 255 cases the portion of intestine which was involved was not given. The cancer involved the liver and gall-bladder 979 and the pancreas 92 times. Cancer of the large intestine exclusive of the rectum occurs most frequently in the sigmoid flexure, then in the cæcum, then in the hepatic and splenic flexures and other portions of the colon.

Three times as many men as women are affected. Like carcinoma in other portions of the body, that of the intestine is most frequently found between the thirtieth and fiftieth years of life, although it is also seen as early as the sixteenth year. It is almost invariably primary and solitary. Multiple nodules may in rare instances arise as such, or they may be due to projection through the mucous membrane, or be the result of metastasis through the peritoneal cavity. There have been several instances reported in which these peritoneal metastases have so far developed as to produce one or more stenoses in the intestine.

The different forms of cancer occur in the following order: cylindrical with a glandular structure, medullary, gelatinous, scirrhous. In structure and method of growth carcinoma of the intestine closely resembles carcinoma of the stomach. (Page 370.) Carcinoma of the intestine leads to early ulceration, with the perforation of small hemorrhages and possibly perforation into the free peritoneal cavity, or into some hollow organ, or externally. It also tends to grow circularly, and thus to produce stenosis with hypertrophy and dilatation of the intestine above it. (Page 296.) There may be acute obstruction with ileus. Even in the rare cases in which the tumor grows longitudinally stenosis is still likely to occur. Or invagination may be the result. The effect upon the mesentery is at first to lengthen it; later it becomes involved by the carcinoma and contracts.

Carcinoma of the intestine, like that of the stomach, may extend by continuity, by the bloodvessels (liver), by the lymph-vessels, and by the peritoneum. Early metastases are the exception. Hauser says that gelatinous carcinoma produces metastasis in the serosa, the lymph-vessels, and the bones rather than in the liver; but medullary carcinoma infects chiefly the regional lymph-glands, and scirrhous produces metastasis in the liver.

The clinical symptoms due to carcinoma of the intestine are chiefly those of chronic intestinal stenosis. Usually a tumor can be

made out, and there may also be symptoms due to the ulceration. In some instances there are few or even no characteristic symptoms for a considerable time. This is especially true of tumors developing in elderly persons. In such cases acute ileus may be the first thing complained of. When the abdomen is opened either before or after death, there will be found the large circular stenosing tumor. The stenosis may be changed to complete obstruction by some small foreign body, or by kinking in the affected intestine, while in many cases no especial cause for the suddenness of the attack can be made out. There may also be invagination or a volvulus. In other cases the palpable tumor first excites the suspicion of the patient. In such cases distention of the stomach and colon by air or water is a great aid to correct diagnosis. (See page 235.)

Carcinoma of the intestine grows slowly. Its latent period is far longer than that of carcinoma of the stomach. It may exist for several years without producing alarming symptoms. As long as the fecal stream is not interrupted the health of the patient may not be seriously affected. Carcinoma of the intestine is far less malignant than some other forms of carcinoma; for example, carcinoma of the rectum. It therefore offers a favorable field for radical treatment. It produces metastasis at a late period, in many cases not till long after the diagnosis has been made. This, of course, greatly favors the success of the operation.

Symptoms.—The first symptoms noted are usually of a dyspeptic character. There may be constipation alternating with periods of normal intestinal action, or periods of diarrhœa. The severity of these attacks gradually increases, and they are accompanied by more or less abdominal distention, which is always a suspicious sign. Sometimes there are colicky pains, and possibly increased peristaltic action visible through the abdominal wall. Still later the attacks of obstruction are accompanied by vomiting of gastric contents. If the stenosis is absolute, or if there is insufficiency of the muscular wall of the intestine, the vomiting may take on a fecal character. In most cases the ileus follows a longer or shorter period of symptoms of chronic stenosis, but sometimes, as stated above, it occurs in persons considered to be in good health. The symptoms of stenosis of the small and large intestine are given in detail on pages 295–300. It is only necessary therefore to call attention to the fact that they vary greatly in carcinoma of the intestine.

Inflammation may suddenly increase the degree of stenosis, while ulceration may almost as suddenly enlarge the lumen of the bowel.

When the symptoms are characteristic, a probable diagnosis is easily made even though a tumor cannot be felt. If a carcinoma is situated in the hepatic or splenic flexure, it may grow a long time before it becomes palpable. Even a carcinoma of the lower portion of the sigmoid, while giving an indefinite sense of resistance, will oftentimes not be distinctly palpable, especially in the presence of meteorism. When the tumor is palpable, it usually appears hard and its surface uneven.

PLATE XIII.

Carcinomatous Stricture of the Sigmoid Flexure, with Symptoms of Stenosis for Four Weeks. Nearly Perforating Ulcers of the Dilated Portion. (Kocher.)

It may or may not be tender. It has an obscure tympanitic percussion-note. Its motility depends partly upon the portion of intestine affected and partly upon the presence of adhesions. Thus carcinoma of the cæcum or of the transverse colon or of the sigmoid flexure may be very movable. Tumors of these portions are usually not sensitive.

In the later stages of carcinoma of the large intestine the stools are rather typical. They contain blood and pus demonstrable either microscopically or macroscopically. If there is extensive ulceration, the fecal matter will have a gangrenous odor and fragments of necrotic tissue may be observed in it. Symptoms of intestinal catarrh are not of themselves characteristic of intestinal carcinoma, but they are never wanting in the later stages of this disease.

Carcinoma of the intestine is not of itself painful. The pain which accompanies it is due to stenosis, adhesions, inflammation, or ulceration. Tenesmus is a symptom which sometimes occurs if the carcinoma is situated in the rectum or lower portion of the colon, but never if the tumor is situated above the descending colon. It consists of intense and very painful straining at stool, which usually comes on in distinct attacks. It may, however, be continuous. There is often no result of this straining, or perhaps a little mucus or pus or blood may be evacuated. Tenesmus may also be due to invagination, dysentery, or ulcer of the lower portion of the colon, or proctitis or periproctitis. Ascites does not usually develop until the carcinoma has involved the serosa, and it does not become a marked symptom until such involvement is extensive. It is therefore an invariable symptom.

Diagnosis.—When once a diagnosis of carcinoma of the intestine has been established, it is usually not difficult to determine in which portion it is situated. The three chief symptoms are tumor, stenosis, and ulceration, and these vary according to the situation of the new growth. If the carcinoma is situated in the small intestine, its position in the abdomen and free motility are frequently characteristic signs. (Page 246.) Carcinoma of the transverse colon might perhaps yield the same results on palpation as that of the small intestine, but the other symptoms should easily differentiate the two. Carcinoma of any other portion of the colon is distinguished by its position and lack of motility.

Symptoms of stenosis are as a rule better marked the higher the point in the intestine at which the stenosis is placed. (Page 295.) Symptoms of ulceration, however, are more pronounced if the ulcer is situated low down in the intestine.

If a diagnosis cannot be made from the failure of the three chief symptoms mentioned, a greatly increasing cachexia not otherwise explained may point to carcinoma of the intestine. In such cases the new growth will probably be found in the hepatic or splenic or sigmoid flexure. In carcinoma of the sigmoid flexure perforation into the urinary bladder with cystitis and pneumaturia may be the first alarming symptom. In such cases the examination of the urine will show that it contains fecal matter, while bimanual examination will further prove the existence of a pelvic tumor.

On account of the hidden position of the duodenum a tumor of this portion of the intestine is not easily palpable, and if it does not produce stenosis or obstruct the passage of bile and pancreatic juice, its diagnosis may be most difficult. The pain is usually referred to the right of the median line, in which situation the tumor will be felt when it has reached a sufficient size. Papillary tumors by obstruction of the biliary and pancreatic ducts produce early symptoms. Carcinoma of the superior portion produces the same symptoms as carcinoma of the pylorus.

Carcinoma of the intestine must be differentiated from other lesions of the same portion of bowel, and also from affections of the neighboring organs incapable of producing a tumor. The diseases of the intestine which must be ruled out are sarcoma, benign tumors, appendical tumors, tuberculosis, and actinomycosis of the ileocæcal region, chronic intussusception, diseases of the mesentery, encapsulated exudates, and retained fecal masses. In very rare cases the intestine should be thoroughly emptied by repeated administration of suitable laxatives. The differential diagnosis between carcinoma and other affections of the intestine will usually be only a probable one.

Diseases of the neighborhood which must be considered will vary according to the situation of the tumor. If this is situated in the region of the duodenum, one must consider tumor of the pancreas, other retroperitoneal tumors, diseases of the biliary tract, etc. A papillary tumor is hardly to be told from impaction of a biliary calculus above the papilla.

Intestinal tumors in the upper half of the abdomen must be differentiated from tumors of the stomach or tumors of the kidney, wandering kidney, from cholelithiasis, tumors of the bladder, etc.; while intestinal tumors of the lower half of the abdomen must be differentiated from many of the same affections, as well as from foreign tumors. Carcinoma of the hepatic or splenic flexure may easily be mistaken for some affection of the corresponding kidney.

Prognosis.—The course of carcinoma of the intestine is a variable one. The patient may die of acute or chronic obstruction, or of cachexia, or of exhaustion on account of the continuous diarrhœa. Such exhaustion proceeds more rapidly if the patient limits his diet in order to avoid the pain which follows eating. Among fatal complications may be mentioned metastasis, perforation into the peritoneal cavity, peritonitis, and perforation into other organs or externally.

It is difficult to estimate the duration of life after the development of intestinal carcinoma, since it may exist for a considerable time before diagnosis is made. It may be given as a general rule that life continues longer the lower down in the intestine the situation of the carcinoma. This does not apply, however, to carcinoma of the rectum, which is more rapidly fatal than that of the colon. Nothnagel says that carcinoma of the colon produces death in periods varying from six months to two years. Mikulicz has known several instances in which patients lived from two to four years after the

establishment of an artificial anus for inoperable carcinoma of the colon. According to his statistics, the duration of life after the first serious symptoms varies from three months to six and one-half years, the average being two years.

Treatment.—The treatment of carcinoma of the intestine is purely surgical. From the moment when there is suspicion of this trouble the necessity for operation should be considered. The counterindications for any sort of operation are: 1. A general condition of the patient so bad that he cannot withstand the operative shock. 2. The absolute certainty that a radical operation is impossible; this may rest upon the presence of metastases, or upon the unfavorable situation of the tumor, or upon the existence of extensive adhesions when stenosis or other symptoms do not require the performance of some operative procedure. 3. Extensive metastases, ascites, etc., which make it useless to perform even a palliative operation.

Operative procedures are more easily performed and are more successful in the case of carcinoma of the intestine than in case of carcinoma of the stomach. The mobility of the adjacent intestine makes it usually possible to eliminate the affected portion, and when this cannot be done a colostomy may be performed which will be of far greater benefit to the patient than the corresponding jejunostomy in gastric carcinoma.

Radical operation is to be performed whenever possible. The size of the tumor is no counterindication since metastases occur at a late period.

The radical operation for carcinoma of the intestine is the resection of the affected portion of the intestine, together with the portion of the mesentery which contains affected glands. The principles of this operation will be described on page 468. If the tumor is situated in the small intestine, the operation is to be completed at once, while operation upon the large intestine had better be carried out in two stages.

Whether a radical operation is possible will depend upon the extent of the tumor, its adhesions, and the possibility of removing all infected glands. The degree to which the general health has been disturbed is also of importance; thus the radical operation should rarely be performed during an attack of acute ileus. Even with chronic stenosis it is often justifiable to perform first a palliative operation in order to allow the dilated and paretic and possibly ulcerated intestine to regain something of its normal condition before performing a radical operation. A simple colostomy may be carried out with a local anæsthesia, then two to four weeks later, when both patient and intestine are in a healthier state, radical operation may be performed. At the time of radical operation the peritoneal cavity may be protected from infection by the artificial anus if one covers the operative area with a piece of sterile cloth and clamps together the cut edges of the peritoneum of the skin and the cut edges made in the protecting cloth. (See page 209.) If the disease of the large intes-

tine extends as far as or involves the rectum, the union of the cut ends of intestine after resection of a tumor is extremely difficult. However, one wishes to avoid an artificial anus if possible. In such circumstances Rotter's recto-colostomy may be performed; or the transverse colon may be sutured into the sphincter ani. Other conditions will require special procedures. Thus it may be necessary to close both ends of the intestine and to anastomose the ileum with the transverse colon or sigmoid flexure.

The palliative operations which may be performed for intestinal carcinoma are: 1, elimination of intestine; 2, entero-anastomosis; 3, artificial anus.

1. When conditions permit, elimination of the affected intestine is the most serviceable palliative operation since the growth of the tumor is less active when it is freed from the constant irritation of passing feces. Moreover, pain is lessened, the results of exhausting stenosis are avoided, and the life of the patient is prolonged. The elimination may be partial with closure of the proximal end, or complete with the establishment of an external fistula. Each has its advantages, though if radical operation is to be performed at a later date, the second method is preferable since the intestine will not need to be opened at a second operation.

2. Simple entero-anastomosis is only indicated when the patient is not in a condition to permit an incomplete or complete elimination to be performed. The mortality of this operation is less than that of elimination or resection, but it is still, according to Wölfler-Schloffer, about 30 per cent.

3. The establishment of an artificial anus is indicated in all cases of carcinoma with ileus. Otherwise it should only be performed if the weak condition of the patient or the situation of the stenosis renders another operation impracticable. A local anæsthetic will usually suffice. The bowel may be opened at once or later. When possible, the abdomen should be exposed through an incision 4 to 5 cm. long (1.6 to 2 inches) in order that knowledge may be gained of the extent, situation, and mobility of the tumor. This knowledge will be of service in deciding the question of subsequent radical operation.

Wölfler's statistics in 1896 showed a mortality of 40 per cent. from resections of the intestine. There were 84 resections of the small intestine with a mortality of 30 per cent., 69 ileocæcal resections with 42 per cent., 81 of the large intestine with 49 per cent. Resection to cure artificial anus was followed by 22 per cent. of mortality, that for tuberculosis by a mortality of 27 per cent., for stricture 35 per cent., and for new growths 54 per cent. More recent statistics by de Bovis show a mortality of 38 per cent. after resection for new growth. One-fourth of the deaths were due to collapse, more than half to peritonitis. The results which followed resection performed in two stages were far better. Mikulicz lost only 2 out of 16 patients operated upon by this method.

The mortality due to palliative operations is given by de Bovis as

follows: enterostomy, 39 per cent.; entero-anastomosis, 28 per cent.; elimination of the intestine, 33 per cent. Individual operators have published more favorable reports.

Carcinoma of the intestine can be permanently cured. Numerous operators have reported cases in which ten years have elapsed since operation without recurrence. Mikulicz and Körte have each reported upon 12 operations performed more than four years ago; 9 of these patients were alive and free from recurrence at the time of report, equal to 37 per cent. of radical cures.

The prolongation of life after colostomy varies between one and a half months and four and a half years, with an average, according to Mikulicz's experience, of twenty-one months. The average duration of life after entero-anastomosis is eight and a half months.

If no surgical treatment of intestinal carcinoma is possible, one has to content himself with an attempt to relieve the constantly increasing pain, which even without obstruction will be felt as the carcinoma extends to the mesenteric and retroperitoneal glands or the parietal peritoneum, or causes adhesions to neighboring organs or the parietal peritoneum. The complications which are to be noted are stenosis, catarrh, and occasionally hemorrhage. The treatment of these symptoms is discussed on page 299.

Various narcotics have been used to relieve the pain, being often given in the form of suppositories. Opium exerts an unfavorable action by increasing the existing obstruction to the passage of feces. Still, in advanced cases of intestinal carcinoma one is obliged to give morphine from time to time, in order to relieve the intense suffering.

CHAPTER XIX.

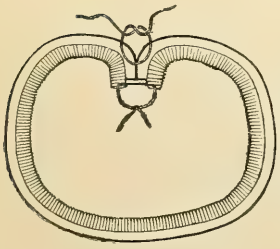
OPERATIONS UPON THE STOMACH AND INTESTINE.

TECHNIC OF OPERATIONS UPON THE STOMACH AND INTESTINE.

Modern intestinal surgery rests upon the development of the intestinal suture and its substitutes. An opening in the alimentary canal may be closed by suture, ligature, button, or other apparatus, or by the plastic use of some other tissue, for example, the omentum.

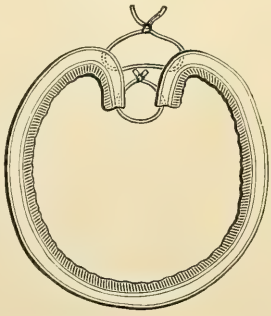
Intestinal Suture.—A serviceable intestinal suture depends upon the physiological law that opposed serous surfaces quickly and firmly adhere whether or not the other layers of the intestinal wall are approximated. Jobert in 1824 was the first to utilize this principle. Lembert worked out in 1826 a more practical method, which, as modified by Czerny and Albert, is in use to-day. In making a Lembert suture

Fig. 102.



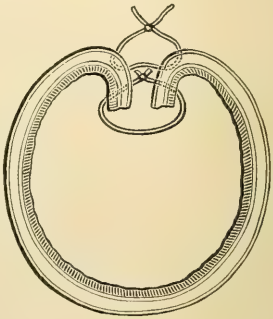
The Lembert suture.

Fig. 103.



Czerny's intestinal suture.

Fig. 104.

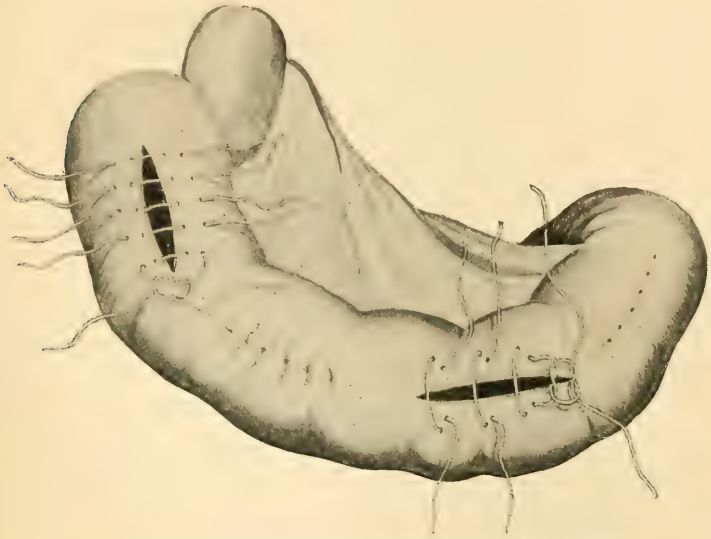


Albert's intestinal suture.

the needle enters and leaves the serous surface, but does not penetrate the mucous membrane. (Figs. 102, 105, and 106.) This suture alone does not give a secure closure in all cases since the mucous membrane may curl up and expose the suture-line. In this manner infection may spread upon the serous surfaces and lead to perforation. For this reason a preliminary suture of the external coats of the intestine is recommended by Czerny (Fig. 103), and a suture of all of the coats of the intestine is advised by Albert (Fig. 104). The objection made to Albert's method, that it exposes the whole suture to infection through the needle-puncture of the stitches, has proved to be groundless. This method of suture is the one usually followed by Mikulicz. Under certain circumstances a third row of stitches may be necessary which

includes simply the serous membrane, or the serous and muscular layers. This third row should not be employed as a routine practice since a dangerous narrowing of the intestinal lumen may be caused thereby.

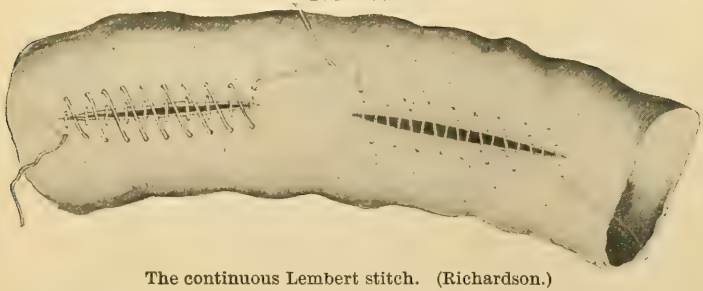
FIG. 105.



Application of the interrupted Lembert suture. (Richardson.)

Whether the suture should be introduced from within the intestine (Fig. 107) or from the outside (Fig. 108) is immaterial. A good plan is to introduce the first row from within and the second row from without the intestine. This gives a more accurate approximation and brings the knots of the first row into the lumen of the bowel.

FIG. 106.

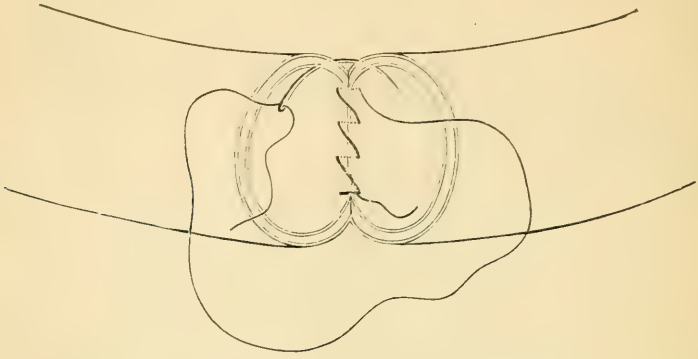


The continuous Lembert stitch. (Richardson.)

An intestinal suture may be either interrupted or continuous. The latter method has the advantage of rapidity. It has the disadvantage that if a single stitch cuts out, or is too loose, a considerable portion of the suture may become insufficient; consequently if the tissue is badly nourished or brittle, a continuous suture is unsuitable. A con-

tinuous suture also requires considerable practice. When practicable it may be used for either the inner or the outer row of stitches.

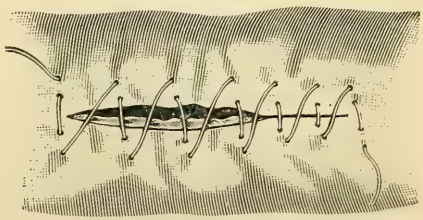
Fig. 107.



Continuous intestinal suture introduced from within the bowel.

If a continuous suture is introduced from within the lumen of the bowel, it cannot, of course, encircle its whole circumference. There must remain a gap which will have to be closed by two or three interrupted

Fig. 108.



Continuous serous suture introduced according to Dupuytren's method, the thread not yet drawn tight.

stitches introduced from without. The mucous membrane has a tendency to bulge outward, and should be replaced with thumb-forceps before the stitches are tied. The outer suture may be continuous throughout the whole circumference of the bowel; or if the distance is too great, it may be divided between two or three sutures.

Fig. 109.

Curved intestinal needle (three-fourths natural size).

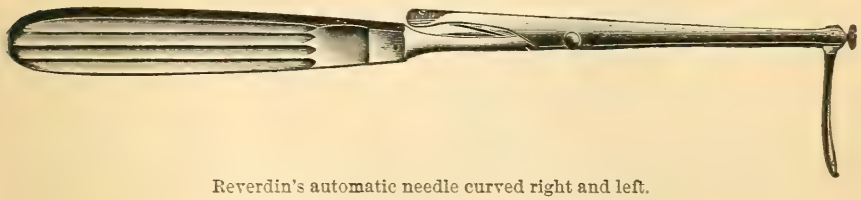
The distance from one stitch to the next depends upon circumstances. In the intestine it should be from 2 to 4 mm. (0.08 to 0.16 inch), and in the stomach from 3 to 6 mm. (0.12 to 0.24 inch). The distance which the needle passes through the intestinal wall before it emerges also depends upon circumstances. The needle should be inserted from 1 to 3 mm. (0.04 to 0.12 inch) away from the cut edge of the bowel for the inner suture.

The second suture should be so introduced that the needle-punctures of the two sutures are not exactly opposite, but alternate.

Lembert passes his needle between the submucosa and the muscularis. Recent investigations have shown that the submucosa is the strongest tissue of the intestinal wall because it contains so many elastic fibres, consequently Albert's method is well suited for the inner row of stitches. The suture must not be too loose lest the closure be imperfect, and it must not be too tight lest it cut through the intestinal wall. Practice is required before one can insert a perfect intestinal suture.

The needle used to suture the intestine has a round transverse section so that it shall push the tissues apart and not cut through them. An ordinary sewing-needle is the best for the purpose. It may be straight or bent. It is convenient to have two sizes of such needles, the finer (Fig. 109) being for the intestine and the coarser for the

FIG. 110.



Reverdin's automatic needle curved right and left.

FIG. 111.

Reverdin's needle with eye in the point, useful in intra-abdominal work.

stomach. A needle-holder is quite unnecessary. It is better to introduce the needle with the fingers unless the suture is applied in a deep cavity; for example, when the duodenum or cardiac end of the stomach is sutured.

Some surgeons make use of a needle having an eye in the point. Reverdin's instruments (Figs. 110 and 111) are good examples.

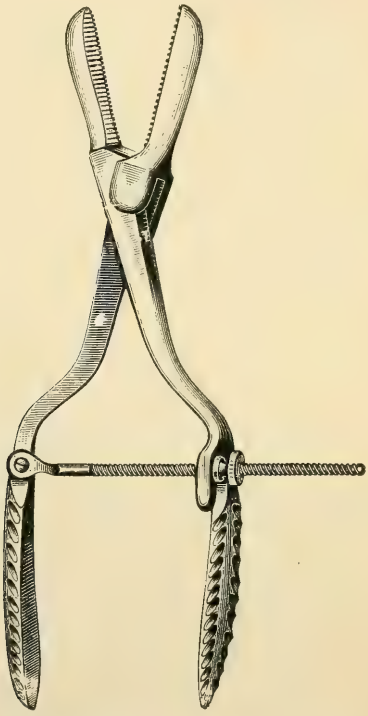
Silk is the material generally employed for intestinal suture. Mikulicz uses catgut for the inner suture because the long silk thread of a continuous suture may lie for months in the intestinal canal. The silk should not be too fine lest it cut through the tissues.

Intestinal Ligation.—A small opening in the intestine may be closed by a simple ligature similar to a ligature placed upon a blood-vessel. It may also be closed by a purse-string suture (Fig. 134) which passes through all of the layers or simply the outer layers of intestinal wall. Simple ligation is impracticable because it approximates mucous membrane to mucous membrane, so that the permanence of the closure depends wholly on the adhesions which may form around the ligature.

If such a ligature is supported by a purse-string suture, the method is satisfactory. The portion of mucous membrane then included in the first ligature will subsequently be cast off into the lumen of the bowel. In the case of the vermiform appendix some surgeons dissect out the mucous membrane before applying the ligature.

Doyen's method of intestinal ligation is the best. It rests upon the principle of crushing the intestinal wall until nothing remains except the resistant serous and submucous coats. He uses a specially constructed forceps, which he calls an "écraseur," and which was

FIG. 112.

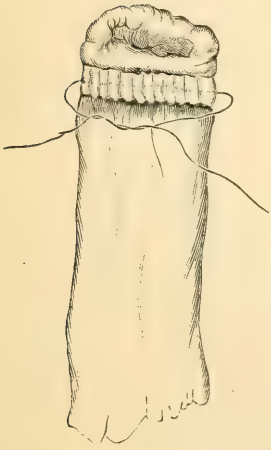


Mikulicz's enterotribe (one-half natural size).

designed for compression of the vessels of the broad ligaments so as to render their ligation unnecessary. This instrument is needlessly heavy, and is capable of exerting a pressure of 2000 kg. (4000 pounds), which is, of course, far greater than one would wish to apply to the intestine. Various modifications of this instrument have been devised, one of which is shown in Fig. 112. The jaws of the forceps are transversely serrated. A screw across the handles of the instrument will maintain whatever pressure is given to the intestine by the grasp of the operator. The intestinal wall can be sufficiently crushed by several repeated attempts, and the use of Doyen's clumsier and expensive instrument is thereby avoided. After a few seconds' pressure the

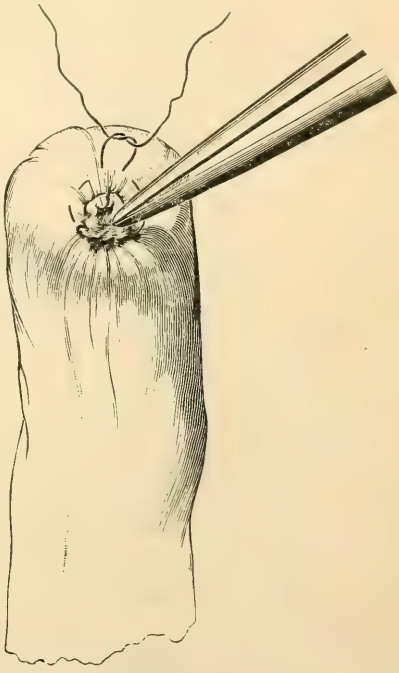
enterotribe may be removed. The intestine will then have the appearance shown in Fig. 113. The transverse groove which is crushed in it is so thin that a thread can be readily seen through it. A No. 1 or 2 catgut or silk ligature is tied around it and the ends of the ligature are left long to serve as traction threads. Any excess of intestine beyond the ligature is cut away, the mucous membrane removed, and the interior of the stump touched with the Paquelin cautery in order to destroy any possible remains of tissue capable of secreting mucus. A purse-string suture is next inserted to the depth of the submucosa.

FIG. 113.



Transverse groove in the intestine caused by the enterotribe

FIG. 114.



Inversion of the ligated stump of intestine and application of the first purse-string suture.

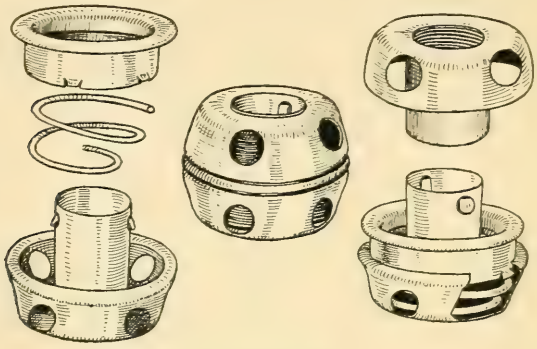
The stump is inverted by thumb-forceps (Fig. 114) and the suture tied. Just before this suture is tied, the first ligature is cut with scissors. A second purse-string suture is placed outside the first, and finally the intestinal stump is dusted with iodoform powder.

It is well not to cut the stump too short lest the first ligature slip off during subsequent manipulations. If this accident occurs, the intestine should be clamped at once and a ligature reapplied in a new situation.

This method of ligation is easier and more certain than an ordinary suture. Furthermore, it can be carried out aseptically since no intestinal contents escape, which it is impossible to avoid in the ordinary intestinal suture. However, suture of the intestine or stomach can be

carried out in accordance with Doyen's principle. If the surrounding peritoneum is already infected, so that drainage is necessary, the surgeon may content himself with a single purse-string suture in place of the more complicated method described above.

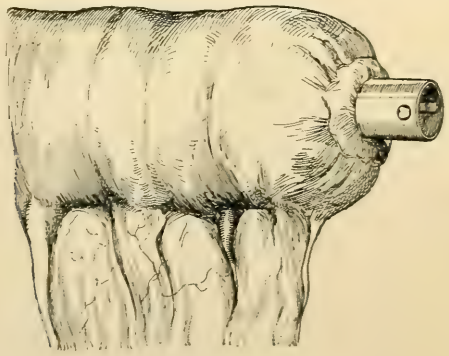
FIG. 115.



Murphy button.

Intestinal Buttons and other Forms of Apparatus.—The intestinal button is employed to establish anastomosis between two hollow organs, such as the stomach, intestine, or gall-bladder. It may be inserted in the end of the organ or in its side. The first and the best apparatus of this sort was devised by Murphy. It consists of two halves which are made of steel and nickel-plated. (Figs. 115.) Each

FIG. 116.

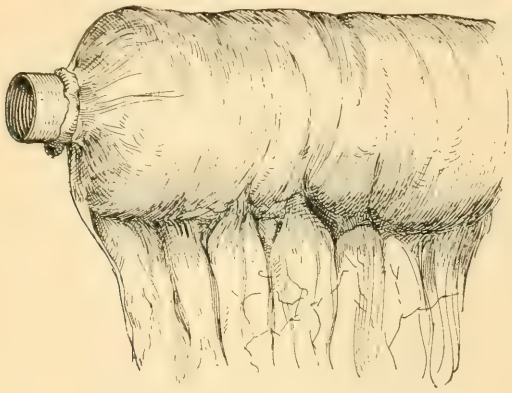


Murphy button—male half held by purse-string suture.

half has a short tube attached to it, and the calibre of these tubes is such that one slips within the other. The lumen of the outer one, sometimes called the female half of the button, is provided with a screw-thread, into which spring hooks upon the male half of the button catch as the halves are pushed together. The two halves can only be separated by unscrewing one from the other. The central

tube, formed when the halves are pressed together, allows the passage of feces. The buttons are elsewhere rounded so that they may pass easily through the intestine when they have become loosened by necrosis of that part of the intestinal wall which is grasped between them. Small holes permit the escape of any secretion which may be formed within the button. These buttons are made in various sizes.

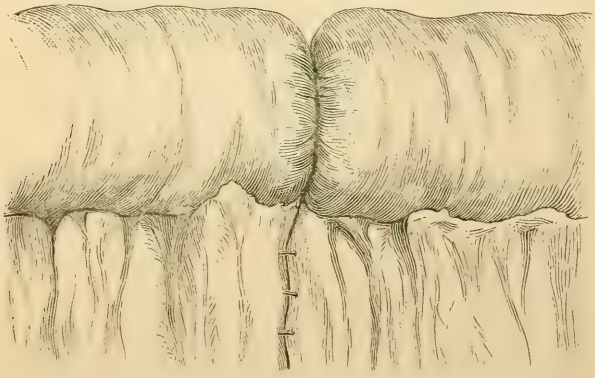
FIG. 117.



Murphy button—female half held by purse-string suture.

The button is introduced as follows: The free end of the intestine is encircled by a purse-string suture at a distance of from 2 to 3 mm. (0.08 to 0.12 inch) from the cut edge. Care must be taken that the mucous membrane does not project. If the anastomosis is to be made

FIG. 118.

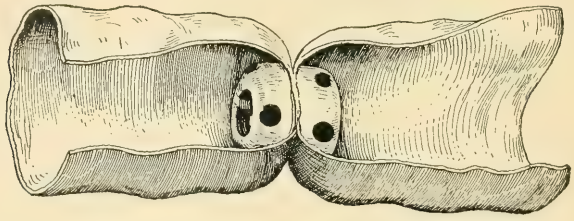


Murphy button—parts approximated and mesentery sutured.

in the side of the intestine, an incision at least two-thirds of the diameter of the button to be used is made through the serous and muscular coats and similarly surrounded by a purse-string suture. (Fig. 120.) The threads are drawn tense, the mucous membrane is divided and caught with a pair of forceps, and the half of the button seized with

artery-clamps and introduced. (Fig. 121.) The male half of the button is heavier than the female, and should therefore be placed in the lower portion of the intestine. The purse-string suture is next drawn tight and tied. (Figs. 116, 117, and 122.) Only the tip of the button projects, and any mucous membrane which is in the way of a smooth serous apposition should be cut away. In a similar manner the button is introduced in the free end of intestine which has been divided transversely. Any

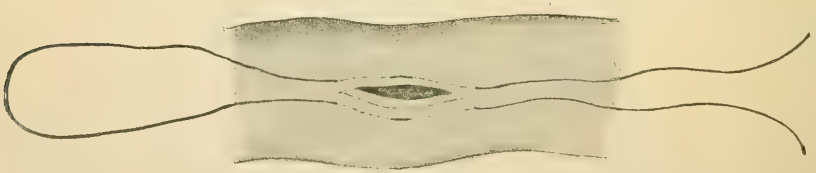
FIG. 119.



Section of end-to-end anastomosis by means of Murphy button.

fluid which escapes from the stomach or intestine during this procedure is quickly wiped away. The lumen of the button may be stopped with gauze, or it may previously be filled with soft agar. The bowel in the vicinity should be lightly compressed to prevent its contents from escaping. The second half of the button is introduced in the opposing intestine in a similar manner. The clamps are removed and the halves of the button are pressed firmly together so that the serous surfaces of the intestine are everywhere in contact.

FIG. 120.



Lateral incision in the intestinal wall ready for introduction of the female half of a Murphy button.

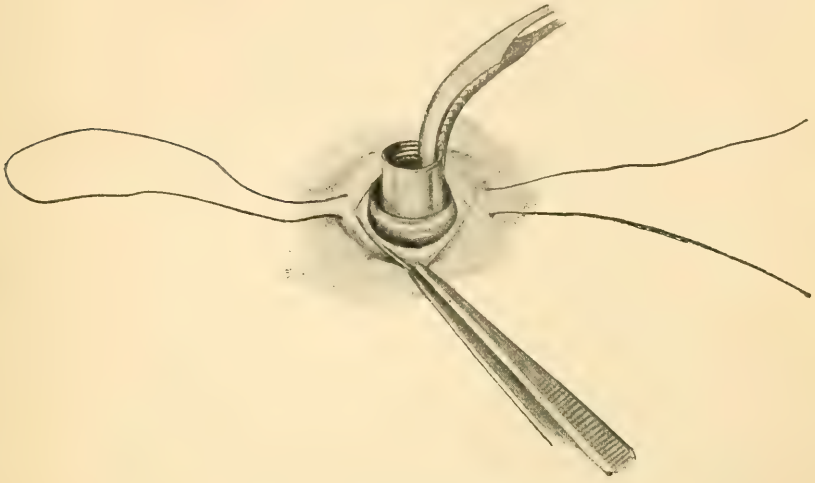
(Figs. 118, 119, and 122.) The pressure applied to accomplish this end need not be great, and should always be made upon the rounded portion of the button, never upon the sharp inner edge. The pressure should not be so great as to cause speedy necrosis of the portion included in the intestinal wall. The necrosis should take place gradually as the result of the pressure due to the steel spring in the button. One should examine a button carefully before employing it, in order to see that it has no sharp angles and is otherwise in perfect condition. If a defective button is employed, perforative peritonitis may follow.

If the button is properly introduced, it is unnecessary to insert

additional Lembert sutures. Still, one should not hesitate to employ these if union seems to be weak at any point. This is a good plan for those who have had only slight experience with this apparatus.

The anastomotic opening thus produced is about the size of the tube of the button, and it does not appear to grow smaller with the

FIG. 121.

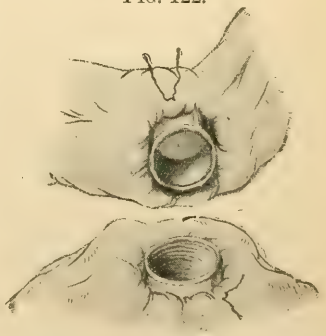


Introduction of one-half of a Murphy button.

lapse of time. The button loosens in about eight days and gradually works its way outward, reaching the anus in from two to four weeks.

A button has the advantage over a suture that it can be introduced in far less time. The anastomosis is not a more certain one except in the hands of beginners. Its chief disadvantage is that it is a foreign body, and while in most cases it passes through the intestine without trouble, it sometimes remains above the anastomosis. If it once reaches that position, it will probably never pass spontaneously since the anastomotic ring has a smaller diameter than that of the button. This unfortunate result of a gastro-enterostomy has compelled several surgeons to open the stomach at a later date in order to remove the button. Hildebrandt uses a button in which the diameter of the male half is greater than that of the female, but even this device has not always prevented the button from lodging above the anastomosis.

FIG. 122.



Intestinal anastomosis with a Murphy button, showing the halves in position ready to be pushed together.

The button may remain for a long time in the anastomosis and give rise to trouble. This result may be due to partial necrosis of the

included intestinal walls, so that the button is fixed by tissue which continues to live. Necrosis of the intestinal wall and perforation may be the outcome. Even if this does not occur, the passage of feces will be much interfered with by the presence of the button.

In some cases the button loosens too soon, as early as the third or fourth day, at a time when the adhesions are not sufficiently firm to prevent the possibility of separation of the intestinal ends.

The lumen of the button may be obstructed by fecal matter and ileus result. This accident is especially common in the large intestine, and for this reason most surgeons do not employ the button for anastomosis involving the colon.

It will thus be seen that the Murphy button is not an ideal apparatus in spite of its many advantages. Some surgeons who previously made use of it have since given it up. Czerny is its most enthusiastic admirer in Germany, and uses it under all circumstances, even in the large intestine.

Mikulicz and the majority of German surgeons consider a good intestinal suture preferable to an anastomosis secured by the use of a button, and employ the latter only under circumstances in which great rapidity of operation seems essential. For example, Mikulicz used it for gastro-enterostomy or entero-anastomosis as palliative operations in patients suffering from carcinoma, and for cholecystostomy under the same circumstances. The saving of five to fifteen minutes in the length of the operation is of great importance for such enfeebled patients. The button frequently remains in the stomach when a patient is weak and near the end of life. Mikulicz also uses the button to unite the stump of the stomach after resection with the jejunum. (See Fig. 188.) Many men have attempted to improve the Murphy button, but without success. Others have made buttons out of absorbable material, but no other device has commended itself sufficiently to be widely adopted.

FIG. 123.

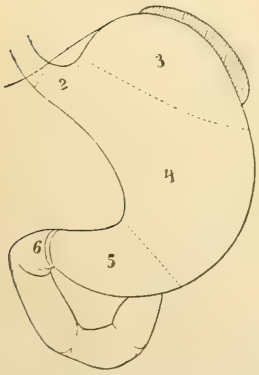


Diagram of stomach: 1, cardiac orifice; 2, cardiac portion; 3, fundus; 4, body; 5, pyloric portion; 6, pylorus.

Plastic Closure of Alimentary Defects.—If an opening in the alimentary canal cannot be closed in one of the ways previously described, it may be possible to repair it by making use of some living tissue in the neighborhood. This is especially true of the stomach. Several men have covered with omentum perforations in this organ which could not be sutured, and have succeeded in saving their patients. Reering has shown by experiments upon animals that a large portion of the gastric wall can be replaced by the intestinal wall, and that the latter will maintain its vitality and unite to the stomach if it remains attached to its mesentery.

The omentum is frequently used to cover a weak suture in the

stomach or intestine for the purpose of giving greater protection against perforation.

The Technic of Special Operations upon the Stomach and Intestines.—The stomach occupies normally a more or less vertical position in the abdomen. (Fig. 123.) At the pylorus it bends sharply and extends downward and to the right. When the stomach is empty, the lesser curvature extends from above downward and to the left, and then, bending sharply near the pylorus, continues downward and to the right. As the stomach fills, its cardiac portion gradually approaches the median line, while the angle between the cardiac and pyloric portions becomes more acute until the two portions lie almost in contact.

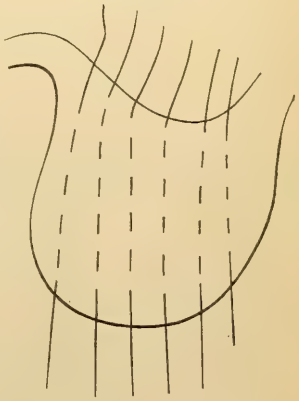
For convenience the stomach is divided into a cardiac portion, a fundus, a body, and a pyloric portion. (Fig. 123.)

As a field for operation the stomach offers more advantages than the intestine. It is so large that its size may be reduced in almost any direction—even transversely—without injury. An exception is made in respect to the pyloric portion. A reduction in the transverse diameter of the intestine is rarely allowable. The stomach is so well supplied with blood that one can make an incision in any direction without risk of resulting necrosis. Indeed, the vessels are so numerous that it is usually necessary to ligate them. The wall of the stomach, and especially its muscular layer, is much better developed than that of the intestine, so that it holds a suture far better. The muscular development in the case of a hypertrophied stomach may be so great as to make a suture somewhat difficult.

OPERATIONS UPON THE STOMACH WITHOUT INCISION OF THE ORGAN.

Divulsion of the Pylorus.—This operation, suggested by Loreta, can be carried out either when the stomach has been opened or by invagination of its wall when it has not been opened. The pylorus is stretched with one or two fingers or with dilators. This operation is rarely performed to-day, as it is more dangerous and less certain than other operations which accomplish its purpose equally well.

FIG. 124.

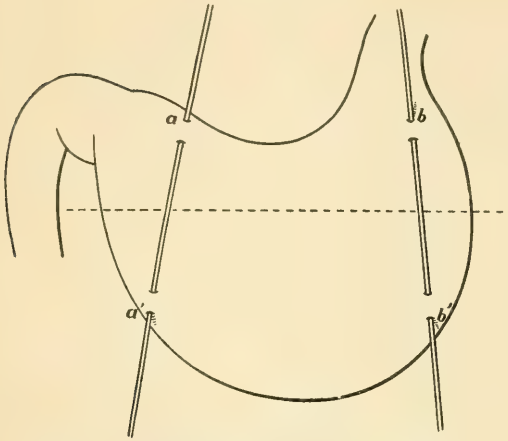


Gastroplication. (Robson.)

Gastroplication.—This operation, suggested by Bircher, consists in folding inward a portion of the stomach-wall in a transverse or a longitudinal direction in order to reduce the size of a much dilated organ. (Figs. 124–130.) It is counterindicated in stenosis of the pylorus.

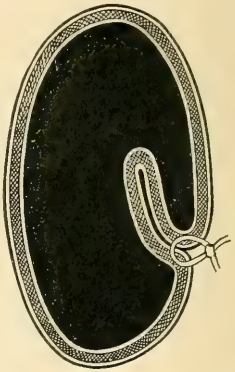
Extramucous Pyloroplasty.—If pyloroplasty is to be performed upon a patient whose mucous membrane is normal—for example,

Fig. 125.



Gastroplication. When the threads *a a'*, *b b'* are drawn up a fold is formed. (Bircher.)

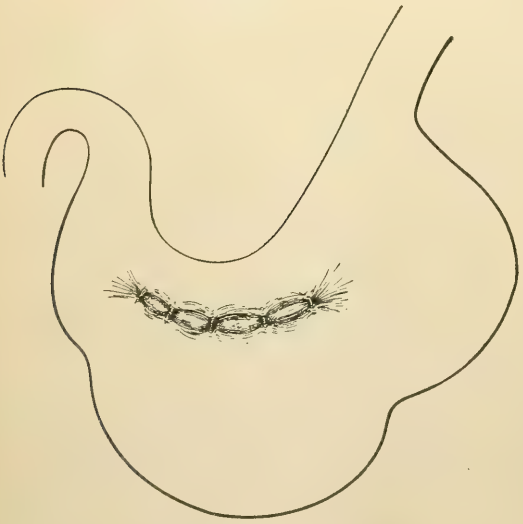
Fig. 126.



Sectional view to show result of operation.

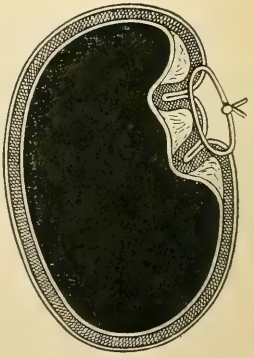
when there is spasm of a hypertrophied pyloric muscle—it is unnecessary to open the mucous membrane. Mikulicz divides the muscular

Fig. 127.



Surface view of the result.

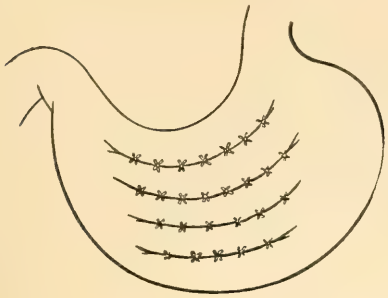
Fig. 128.



Sectional view of the result when two folds are turned in.

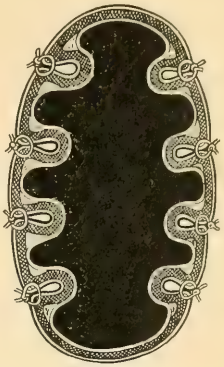
ring with a tenotome introduced beneath the serosa, or he divides all of the layers down to the mucous membrane, making an open wound

FIG. 129.



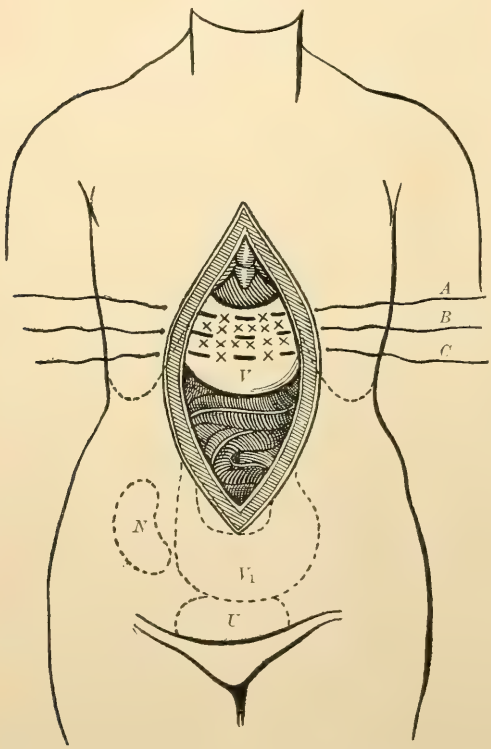
Gastroplication. (Brandt.)

FIG. 130.



Sectional view of the result.

FIG. 131.



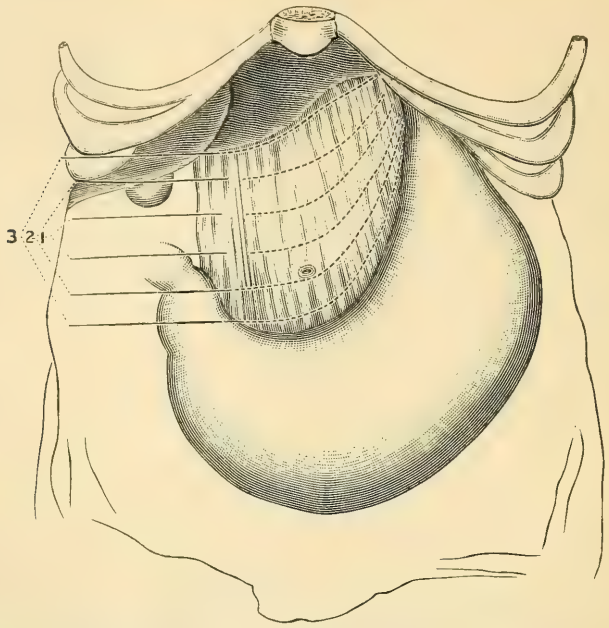
Rovsing's operation for gastroptosis: V, stomach; V_1, position of the stomach before operation U, urinary bladder; N, right kidney; A, B, C, silk sutures; x, x, scarifications.

which is sutured transversely. In most cases he prefers the usual complete pyloroplasty.

Gastrolysis.—This term has been applied to the separation of adhesions existing between the stomach and anterior abdominal wall

or some neighboring organ. Such adhesions may be divided with the knife or bluntly.

Fig. 132.



Suspension of stomach by three rows of interrupted stitches through the gastrohepatic and gastrophrenic ligaments: 1, 2, 3, single stitches of the three rows. (Beyea.)

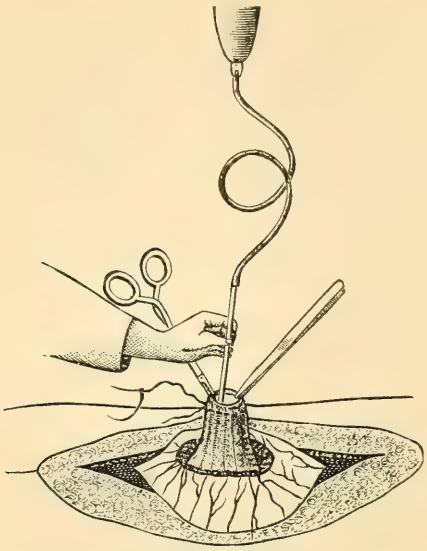
Gastropexy.—A greatly dilated or sunken stomach has been stitched high up to the abdominal wall by Duret, Rovsing, and others. (Figs. 131 and 132.)

OPERATIONS UPON THE STOMACH INVOLVING INCISION OF THE ORGAN.

Gastrorrhaphy.—Simple openings and defects in the gastric walls as a result of injury or ulceration can be closed by one of the methods of suture hitherto described if no complications exist. In the case of ulcerative perforation it is often desirable to freshen the edges of an ulcer before applying the suture. If the area of perforation is adherent to the abdominal wall or to some neighboring organ, as in the case of gastric fistula, the stomach must be separated and the edges of the fistula freshened before suture is applied. In all cases it is to be remembered that the result of the suture depends upon the rapid formation of adhesions between the opposed serous surfaces. One can never be sure that this will take place unless the surfaces thus opposed are covered with normal peritoneum. It is therefore better to sacrifice half an inch or more of the stomach-wall rather than to suture surfaces which on account of old adhesions have lost their peritoneum. The best suture is a linear one. If the defect in the stomach is of irregular

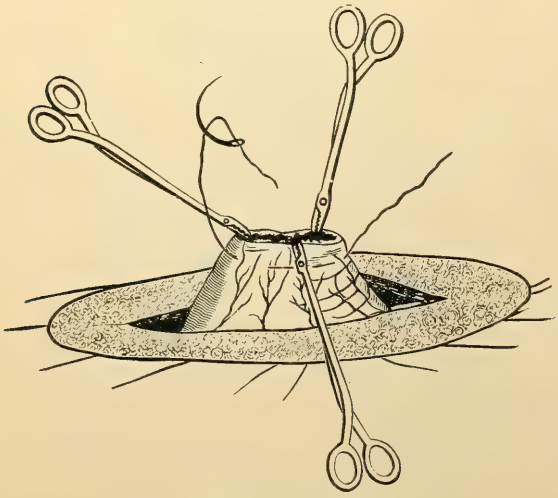
shape, the sutures may be introduced so that three suture-lines will radiate from a common point. This common point represents a weak spot in the suture, and is therefore to be avoided when possible by

FIG. 133.



Purse-string suture used to close small openings in the stomach: irrigation of omental bursa. (Senn

FIG. 134.

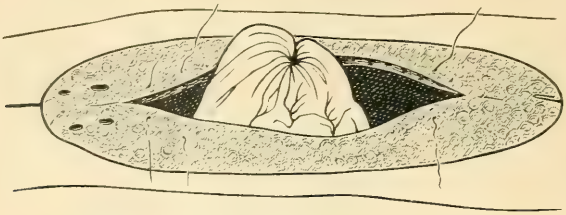


Purse-string suture in place. (Senn.)

excision of gastric tissue here and there and stretching of the parts to be sutured so that a linear suture may suffice. Omentum may be used to cover the suture-line and give additional security.

The wound in the abdominal wall should be completely sutured when possible. If the peritoneum is soiled with gastric contents either before or during operation, an iodoform gauze tampon may be employed to reach from the septic part of the abdomen through the

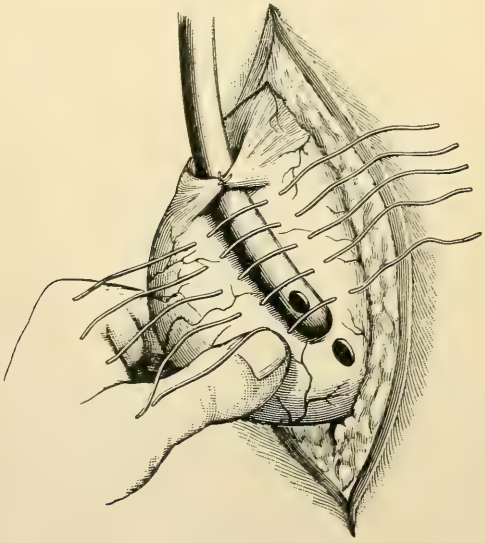
FIG. 135.



Result of purse-string suture when tied. (Senn.)

abdominal wound. In most cases such a tampon should be removed in twenty-four hours lest it produce a gastric fistula. This complication may cause death from starvation, and will also interfere with healing of the wound since a gastric fistula rarely closes spontaneously.

FIG. 136.

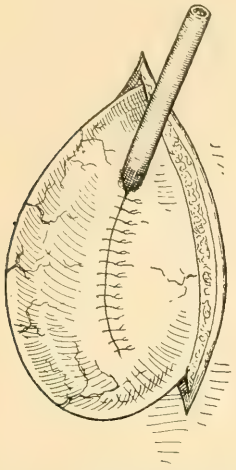


Witzel's method of gastrostomy: infolding the tube. (Richardson.)

Gastrotomy.—Gastrotomy is the opening of the stomach in order to expose its interior, or to remove a foreign body, or to ligate some bleeding vessel, etc. When the end is accomplished, the incision is closed by a double row of sutures. In doubtful cases the abdominal incision should be made in the epigastrium in the median line. Sometimes the surgeon will prefer the left intrarectal incision or an oblique incision. The stomach usually presents itself in the wound. If it is

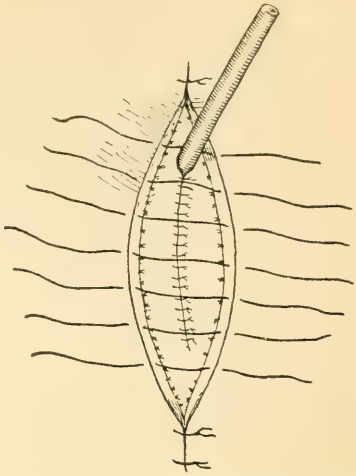
much contracted, it may be found with difficulty. It can scarcely be mistaken for anything else even when it is adherent, if one notices its position, the

Fig. 137.



Witzel's method of gastrostomy : tube in place. (Richardson.)

Fig. 138.

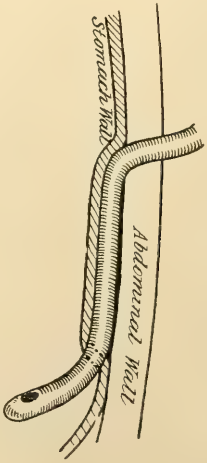


Witzel's method of gastrostomy, showing the manner of fastening the stomach to the abdominal wall : sutures for closing the abdominal wound in place. (Richardson.)

Fig. 139.

Witzel's method, completed. (Richardson.)

Fig. 140.



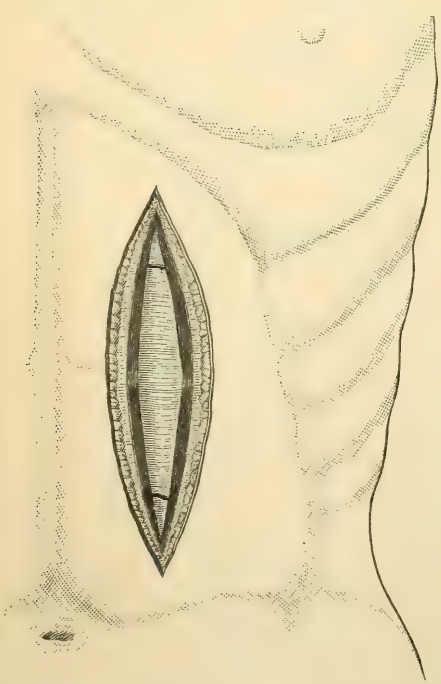
Showing path of the tube in Witzel's method of gastrostomy. (Richardson.)

character of its surface, its shape, the arrangement of the vessels upon its greater and lesser curvatures, and the relation of the organ

to the gastrocolic omentum. Before the stomach is opened, it should be brought forward, as described on page 213, and temporarily shut off by tampons from the general peritoneal cavity. After the incision in its wall has been sutured the abdominal wound should be completely closed. If the wound in the stomach is small, it may be closed by a purse-string suture. (Figs. 133–135.)

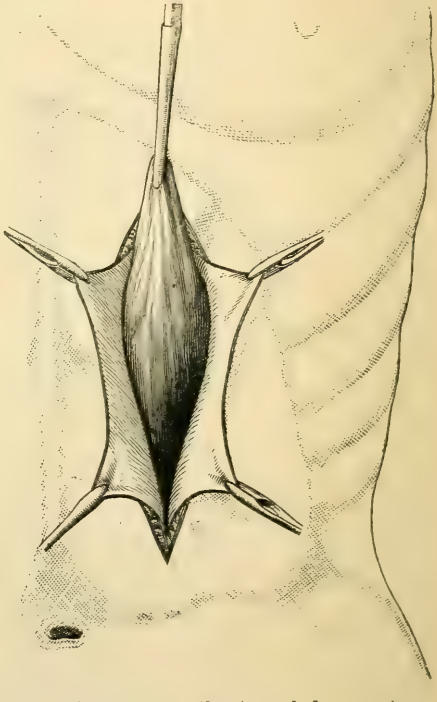
Gastrostomy.—The object of a gastric fistula is to permit an individual to be fed through it either temporarily or permanently. In the case of cicatricial contraction of the œsophagus it sometimes serves for

FIG. 141.



Gastrostomy: incision through abdominal wall. (Terrier.)

FIG. 142.



Gastrostomy: the stomach drawn out. (Terrier.)

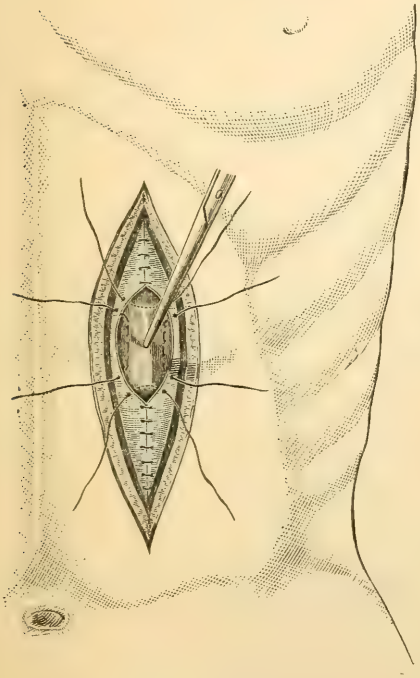
the introduction of sounds to dilate such a stenosis from below; or, if the œsophagus has been wounded, the patient may be fed temporarily through a gastric fistula so as to permit the œsophageal wound to heal undisturbed by the passage of food. The difficulty of this operation consists in so making the fistula that fluid shall pass through it into the stomach while none passes in the opposite direction. The escape of gastric contents through a fistula is disagreeable for a patient. It produces eczema or ulceration of the skin which is extremely painful, and deprives the patient of much needed nourishment.

Gastrostomy has become a most valuable operative procedure since

Witzel showed that a fistula placed obliquely through the gastric wall will not permit the escape of gastric contents. (Figs. 136–140.)

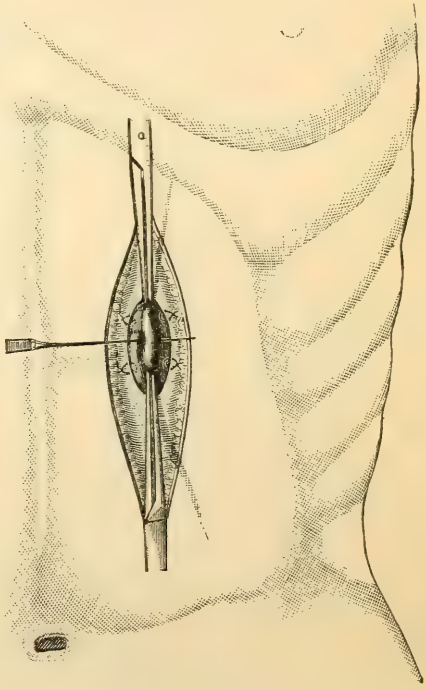
Witzel's method is to make an incision 4 or 5 cm. (1.6 or 2 inches) long through the left rectus muscle and bring out through it a bit of the anterior wall of the stomach about where the pyloric portion joins the body of the organ and near the greater curvature. Here he makes an incision through the serous and muscular layers sufficiently large to admit a slender lead pencil. The mucosa is next seized with forceps, drawn forward, and opened, and a rubber tube 50 to 60 cm. (20 to 24 inches) long and having the diameter of a lead pencil is pushed into the

FIG. 143.



Gastrostomy: first row of gastric sutures. (Terrier.)

FIG. 144.



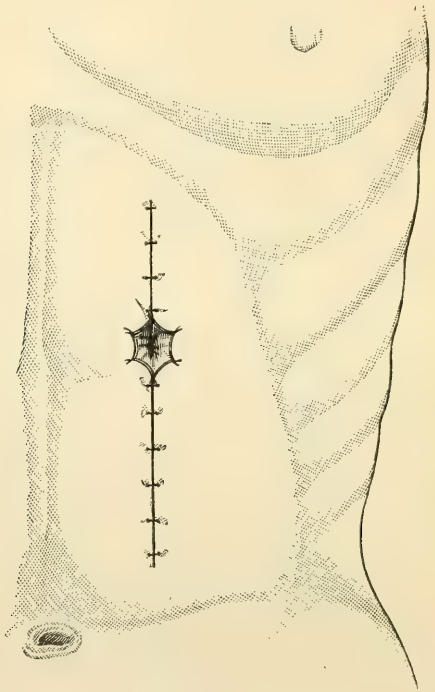
Gastrostomy: division of the serous and muscular coats before the second suture. (Terrier.)

stomach for a distance of 10 cm. (4 inches) and fastened with a catgut suture to the gastric wall. The outer end of the tube is clamped so that the stomach shall not escape. The tube is next laid against the gastric wall and covered in by a number of interrupted stitches which do not, of course, penetrate the lumen of the stomach. One of these stitches should be placed beyond the tube. Altogether there should be at least five or six of them. In this manner a tube is made to lie in a gutter about 4 cm. (1.6 inches) long, and when the sutures are tied the gutter is changed into a canal. The direction of this canal is unimportant, but it must not be so placed as to narrow the pyloric portion.

Witzel recommends the introduction of a second row of stitches, but experience has shown these to be unnecessary. The mouth of the canal is next stitched to the parietal peritoneum and the wound in the latter is so far closed that there is barely space for the drainage-tube to pass through.

The muscles of the fascia and finally the skin are securely stitched. Before the peritoneal cavity is closed, the tube should be tested by pouring water into the stomach and allowing it to flow out again.

Fig. 145.



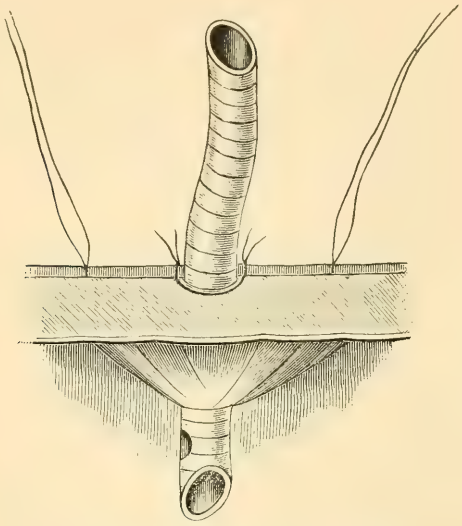
Gastrostomy: suture of mucous membrane to skin. (Terrier.)

Witzel attempted to make a closure of the gastric fistula still more certain by incising the different layers of the abdominal wall in different directions. Other operators have placed the tube in an oblique canal in the abdominal muscles or between the muscles and the skin. Hacker makes an incision through the rectus muscle and then draws the inner edge of the rectus downward so as to accomplish closure of the fistula by pressure of the rectus muscle. Mikulicz has found all of these methods unsatisfactory except the original valvular method of Witzel described above.

A safety-pin is thrust through the drainage-tube and fastened to the skin with sticking-plaster, and the wound is covered with a little sterile gauze, which is also strapped to the skin. In order to avoid the

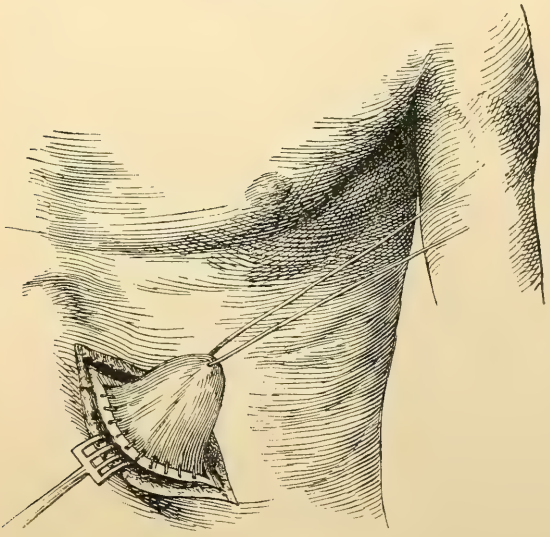
escape of stomach contents through the holes in the rubber tube made by the safety-pin a second larger tube may be slipped over the first and

FIG. 146.



Kader's method: final condition. (Stimson.)

FIG. 147.



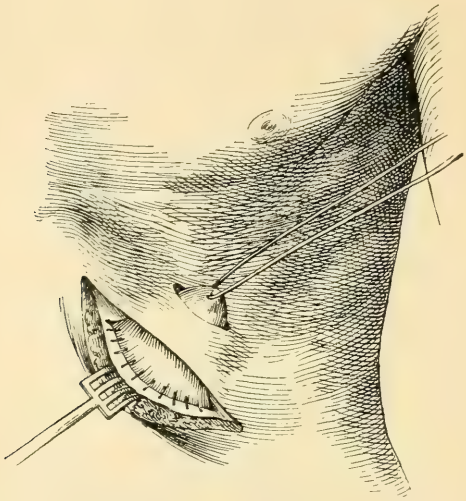
Gastrostomy by Frank's method: cone of stomach stitched into the peritoneal wound.

the safety-pin passed through it alone. The second tube must, of course, fit tightly over the inner one to prevent the latter from slipping through it.

The canal formed in Witzel's gastrostomy ultimately comes to lie

perpendicular to the surface, and yet it prevents the escape of gastric contents. Terrier therefore makes a perpendicular opening at the

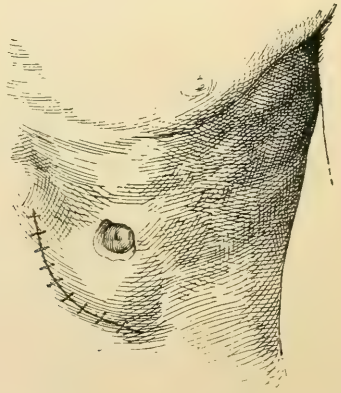
FIG. 148.



Gastrostomy by Frank's method: cone of stomach pushed through the second skin-incision.

time of operation, which will not leak if the cone of stomach is a long one and is sutured in a narrow slit in the rectus muscle. (Figs. 141–145.)

FIG. 149.



Gastrostomy by Frank's method: suture of abdominal wound; stomach stitched in the skin-incision.

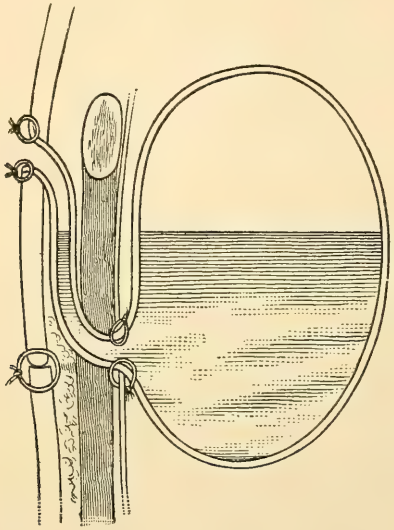
Kader establishes a perpendicular canal at the time of operation by introducing two rows of serous stitches. (Fig. 146.) In this manner the stomach is folded in for a considerable distance. This operation is therefore not adapted to a greatly contracted stomach.

Marwedel forms a canal between the layers of the gastric wall. He

does this by incising the serous and muscular coats for a distance of 4 or 5 cm. (1.6 to 2 inches), opening the mucous membrane at one end of the incision, introducing the drainage-tube and suturing over it the divided serous and muscular layers.

Frank operates by drawing a long cone of stomach out of the abdominal wound and suturing its base to the wound in the peritoneum. He then bores an oblique canal beneath the skin, makes a second incision at its extremity, draws the stomach through it, and opens it after the laparotomy wound has been sutured. (Figs. 147–150.)

Fig. 150.



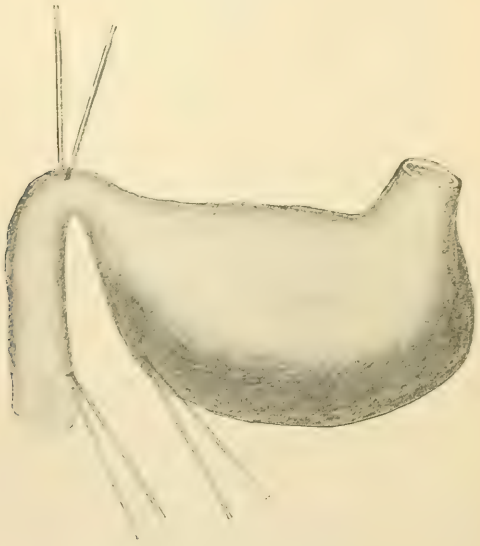
Showing relation at close of Frank's gastrostomy.

These various methods have been altered and combined by different operators. Frank's method and its various modifications cannot be performed upon a contracted stomach. Witzel's and Kader's methods are so simple and give such excellent results that after an experience with them in 150 cases Mikulicz has concluded that there is no excuse for the introduction of more complicated methods of gastrostomy. The fistula acts so perfectly even months afterward that not a drop of fluid escapes alongside of the drain nor after the drain is removed.

The theoretic use of gastrostomy, especially in diseases of the œsophagus and of the cardiac portion of the stomach, is spoken of in connection with affections of the œsophagus. Some directions for nourishment through a gastric fistula will not be out of place. The rubber tube remains constantly in the fistula, being held in place by a strip of plaster through a small hole in which it emerges. Its length outside the body should be 30 or 40 cm. (12 or 16 inches). Its outer end is clamped and is fastened to some convenient portion of the bandage. The bandage is not disturbed for a week after the operation, and after that time is changed once or twice a week. When the patient

wishes to take nourishment, he brings the tube out through a slit in his shirt, but does not need to remove his clothing. Some surgeons remove the tube between meals, but this is not the best practice, for the fistula, which is lined only with serous membrane, tends to contract. Sometimes when the tube has been out only fifteen minutes it is difficult to reintroduce it, hence it is better never to remove the tube except to change or cleanse it, and once a week is often enough for this. If it becomes obstructed, irrigation will almost always open its lumen. Nourishment is introduced by means of a small glass funnel. This is such a simple matter that every patient learns to do it almost at once. In the beginning, only a small quantity should be introduced into the stomach—from 50 to 100 c.c. (2 to 3 ounces) every half hour to an hour. This quantity should be gradually increased and the intervals made longer. With time the patient will learn to feed himself

FIG. 151.



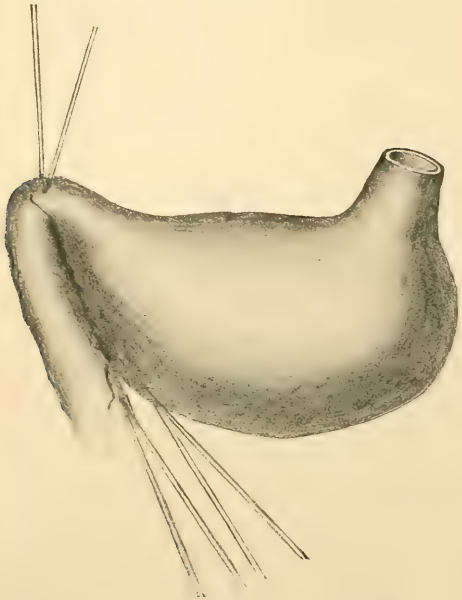
Finney's pyloroplasty: tension sutures.

according to his needs. Nourishment should be introduced immediately after the operation. Any good soup or eggs well stirred, or milk, or wine, or gruel, or various prepared foods are suitable for nourishment. One should be particular not to give the patient repeatedly the same form of nourishment. Finely divided meat, bread, potato, rice, etc., can easily be introduced through the tube, and are far better for most patients than a continuous fluid diet. If necessary, the solid food can be passed through a sieve and thinned with bouillon before it is poured into the funnel. In almost all cases the patient is able to take water and perhaps some other fluid by mouth.

This gastric feeding soon relieves the patient of his thirst, and ordinarily he begins to gain weight. The gain will in most cases not

be great. It will seldom exceed twenty pounds. It is usually greater in younger persons than in those past middle life. This gain is by comparison far less than that which follows gastro-enterostomy or pyloroplasty for stenosis of the pylorus. Even if the same food is given through the gastric fistula, it seems not to have the same nutritive value for the patient as when it is taken by the mouth. The difference is due not to the lack of saliva, whose digestive power is very slight, but to the fact that the psychical stimulation known as appetite has a powerful effect upon the secretion of the gastric juices. A patient with a gastric fistula may be said to be hungry, but he cannot be said to have an appetite. He loses his enjoyment of food and sometimes his liking for the taste and smell of food.

FIG. 152.

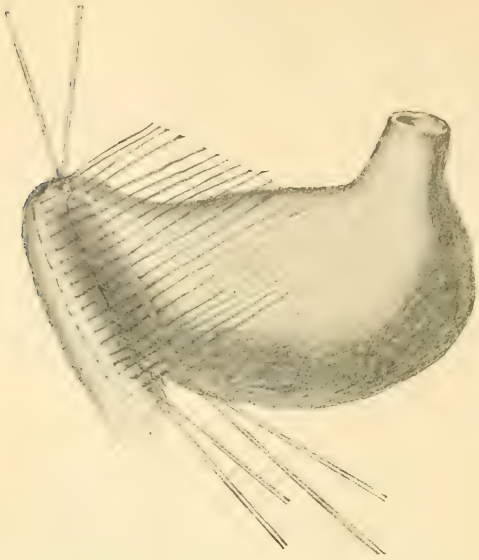


Finney's pyloroplasty: posterior suture.

If a gastrostomy is performed for the temporary nourishment of the patient, it may be necessary to close the fistula at a later date. If the fistula is made according to Witzel's or Kader's method, it is simply necessary to withdraw the tube. The mouth of the fistula becomes covered with a scab which falls off in from six to ten days, leaving a small scar. If the fistula is lined with mucous membrane, a plastic operation will usually be necessary to close it; hence a temporary fistula ought always to be established in accordance with the principle described by Witzel or Kader.

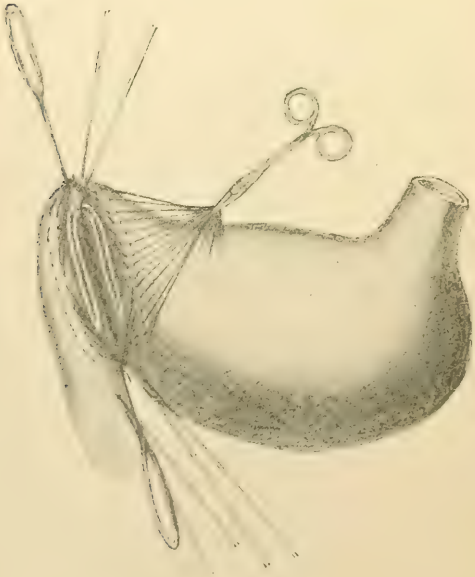
Pyloroplasty.—Heinecke and Mikulicz, working independently, both developed a plastic operation upon the pylorus in order to dilate the pylorus when its stenosis was due to some benign cause. The

FIG. 153.



Finney's pyloroplasty: anterior stitches inserted but not tied.

FIG. 154.

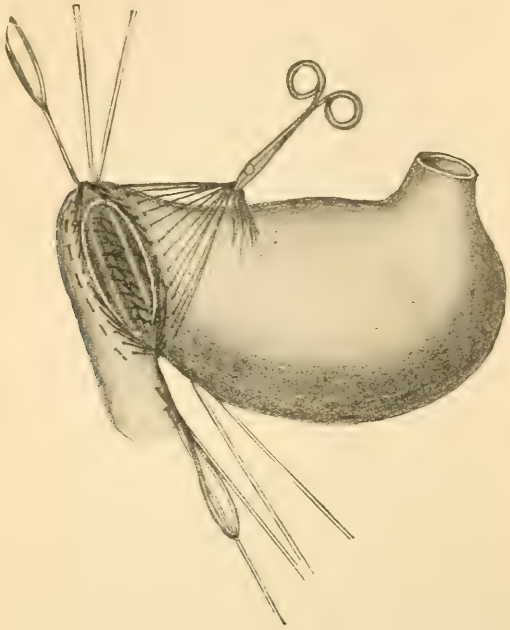


Finney's pyloroplasty: anterior sutures drawn aside; incision made.

pylorus is reached through an epigastric or epimesogastric median incision and drawn forward. It is opened longitudinally for a distance of 4 to 6 cm. (1.6 to 2.4 inches). The edges of this wound are

drawn apart so that the wound can be stitched transversely. The extremities of the original incision become the central point in the suture-line. Two rows of continuous or interrupted sutures are necessary.

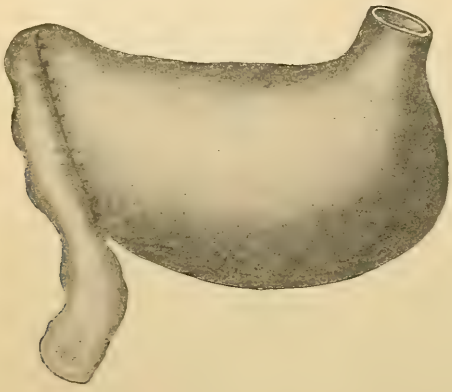
FIG. 155.



Finney's pyloroplasty: posterior suture of mucous membrane.

Theoretically the pylorus can be enlarged to any extent by this longitudinal incision, but practically it is not well to make the incision

FIG. 156.



Finney's pyloroplasty: anterior suture completed.

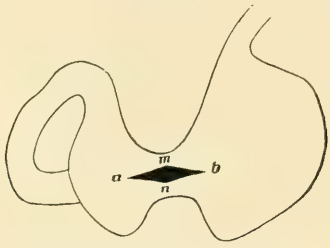
more than 6 cm. (2.4 inches) long lest tension upon the suture make it insecure. A worse error is to make the incision too short. If this

is done, the pylorus is not sufficiently dilated and the stenosis quickly recurs. This has been the mistake in most of the reported failures following this operation. Finney suggests a method of pyloroplasty which gives a very free opening. (Figs. 151–156.)

In certain cases excision of the pyloric ulcer may be combined with pyloroplasty.

Pyloroplasty is counterindicated if the pylorus is fixed high up. Under such circumstances the operation cannot overcome the existing

Fig. 157.



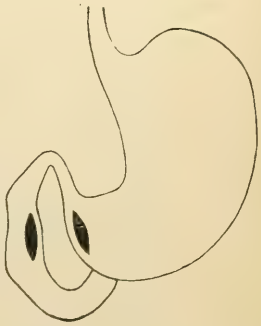
Gastroplasty for hour-glass stomach.

kink, and may even increase it. It is also counterindicated if the pylorus is infiltrated as the result of a present or previous ulcer either in the pylorus or in its neighborhood. Suture of infiltrated or badly cicatrized tissue is not safe; and even if it succeeds, cicatricial contraction will speedily reproduce the stenosis. A fresh ulcer of the pylorus without infiltration is no counterindication to pyloroplasty.

Fig. 158.

Gastro-anastomosis.

Fig. 159.



Gastroduodenostomy.

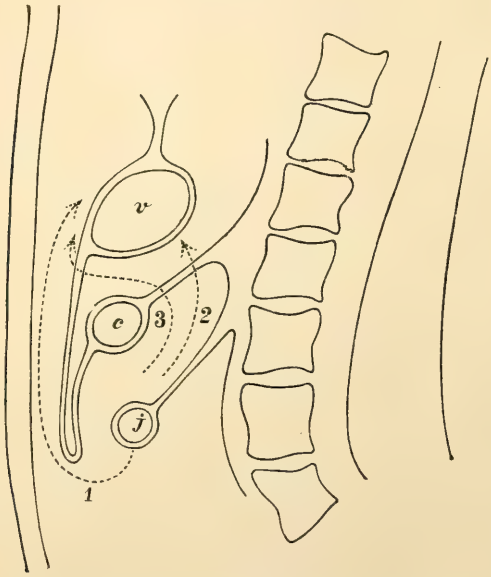
In suitable cases pyloroplasty is to be preferred to gastro-enterostomy. It is technically a simpler operation, and it restores the normal condition of the parts, which a gastro-enterostomy does not do. Furthermore, there have recently been observed a good many cases of peptic ulcer of the jejunum following gastro-enterostomy. Some of these cases have resulted fatally. One should hesitate therefore to

perform gastro-enterostomy if there is hyperacidity of the stomach and a pyloroplasty is possible.

Gastroplasty and Gastro-anastomosis.—Gastroplasty is an operation similar to pyloroplasty. It is indicated for the relief of gastric stenosis such as is present in hour-glass stomach. (Fig. 157.) This condition may also be relieved by a broad anastomosis between the two portions of the stomach. (Fig. 158.) The incision for this purpose may or may not extend into the stenosed portion of the organ. The technic of a gastro-anastomosis so closely resembles that of gastro-enterostomy that a separate description is unnecessary.

Gastro-enterostomy.—An anastomosis between the stomach and intestine may be made at any point in which the two can be brought

FIG. 160.



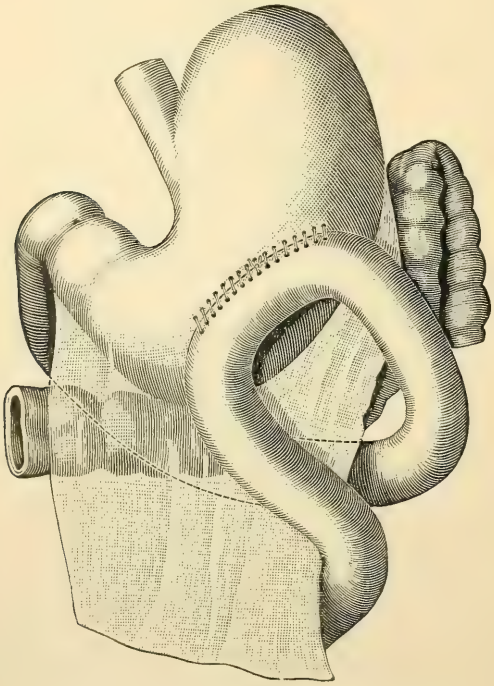
Showing the three methods of gastrojejunostomy which are in use: *v*, stomach; *c*, transverse colon; *j*, jejunum; 1, anterior antecolic anastomosis; 2, posterior retrocolic anastomosis; 3, anterior retrocolic anastomosis.

into contact. The duodenum or upper portion of the jejunum is usually chosen so as to utilize for digestive purposes the greater portion of the small intestine. The upper portion of the duodenum alone is available, as the rest of the duodenum is too firmly fixed. The first few inches of the jejunum are unsuited to anastomosis for the same reason.

Gastroduodenostomy.—Gastroduodenostomy is indicated in those cases in which a stenosed pylorus is fixed high up so that the pyloric portion of the stomach and the superior portion of the duodenum can be easily brought together. (Fig. 159.) The technic of the operation is similar to that of an ordinary gastro-enterostomy.

Gastrojejunostomy.—If there is any obstruction to the normal passage of gastric contents into the jejunum, and such obstruction cannot be overcome and the normal condition of the parts restored, gastrojejunostomy is indicated. The obstruction referred to may be in the pyloric portion of the stomach, or in the pylorus, or in the duodenum, or in the upper portion of the jejunum. It may be due to a tumor, or ulcer, or cicatrix, or a spasm of the pylorus, or to pressure from a tumor outside of the alimentary canal, etc. The first gastro-enterostomy was performed by Wölfler, in 1881, to relieve a patient from pyloric stenosis due to carcinoma.

Fig. 161.



Precolic anterior gastro-enterostomy. (Hartmann.)

Anastomosis of the small intestine with the stomach may be carried out either in front or behind the transverse colon, and in the latter case communication may be established through the anterior or posterior wall of the stomach. (Fig. 160.)

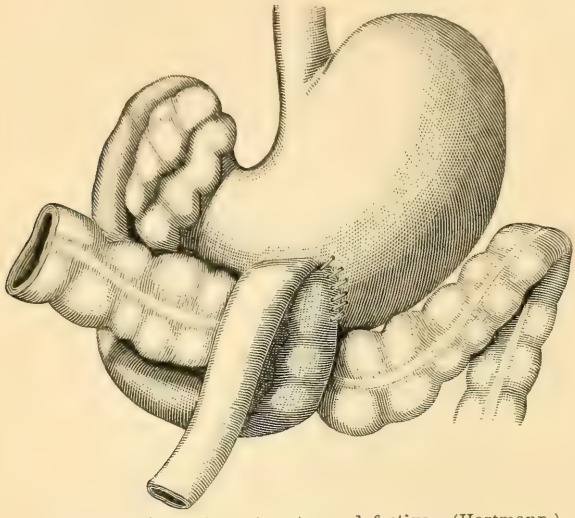
Anterior antecolic gastrojejunostomy was the form first practised by Wölfler. (Figs. 161 and 162.)

In posterior retrocolic gastrojejunostomy as performed by Hacker the small intestine is drawn through a slit in the transverse mesocolon and attached to the posterior wall of the stomach. (Fig. 163.)

Anterior retrocolic gastrojejunostomy has been occasionally per-

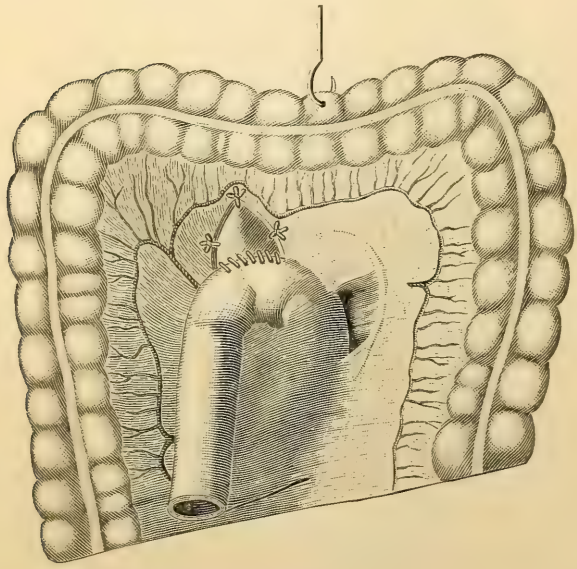
formed by Billroth, Branner, and others, but is less serviceable than the two methods previously described. By this method the small in-

FIG. 162.



Precolic anterior gastro-enterostomy, defective. (Hartmann.)

FIG. 163.



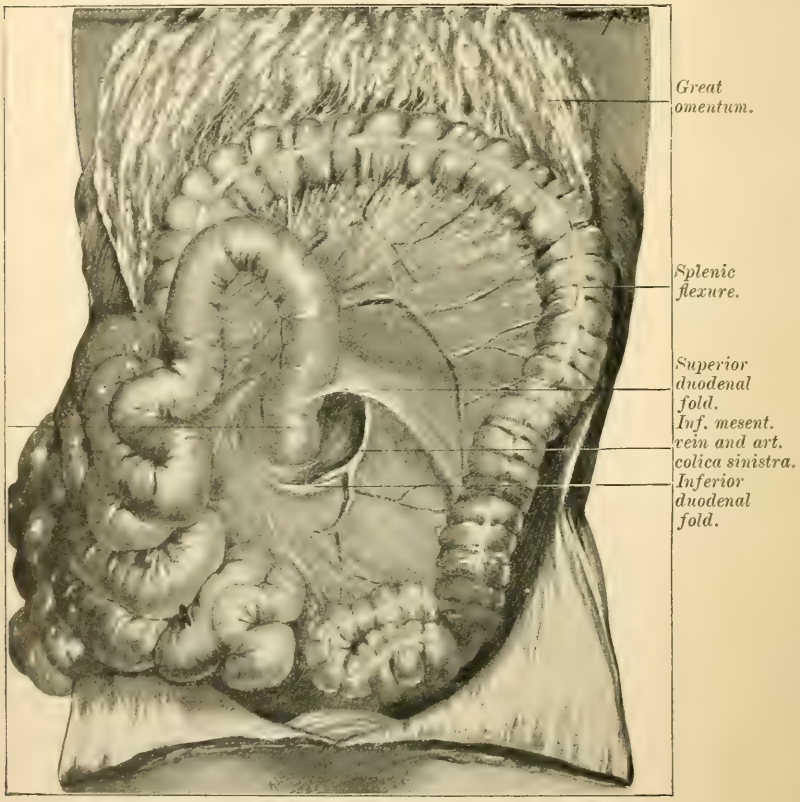
Posterior gastro-enterostomy. (Hacker.)

testine is brought through slits in the transverse mesocolon and in the omentum, and is attached to the anterior wall of the stomach.

Posterior antecolic gastro-enterostomy is theoretically possible, but for obvious reasons is not to be recommended.

Kocher has anastomosed the small intestine to the greater curvature of the stomach either behind or in front of the transverse colon. This method, which may be spoken of as intermediate or inferior gastro-jejunostomy, is less satisfactory than the methods more commonly employed. The dissection of the vascular gastrocolic omentum takes some time, and the idea of attaching the jejunum to the lowest point of the stomach has no especial advantage, since the terms upper and

FIG. 164.

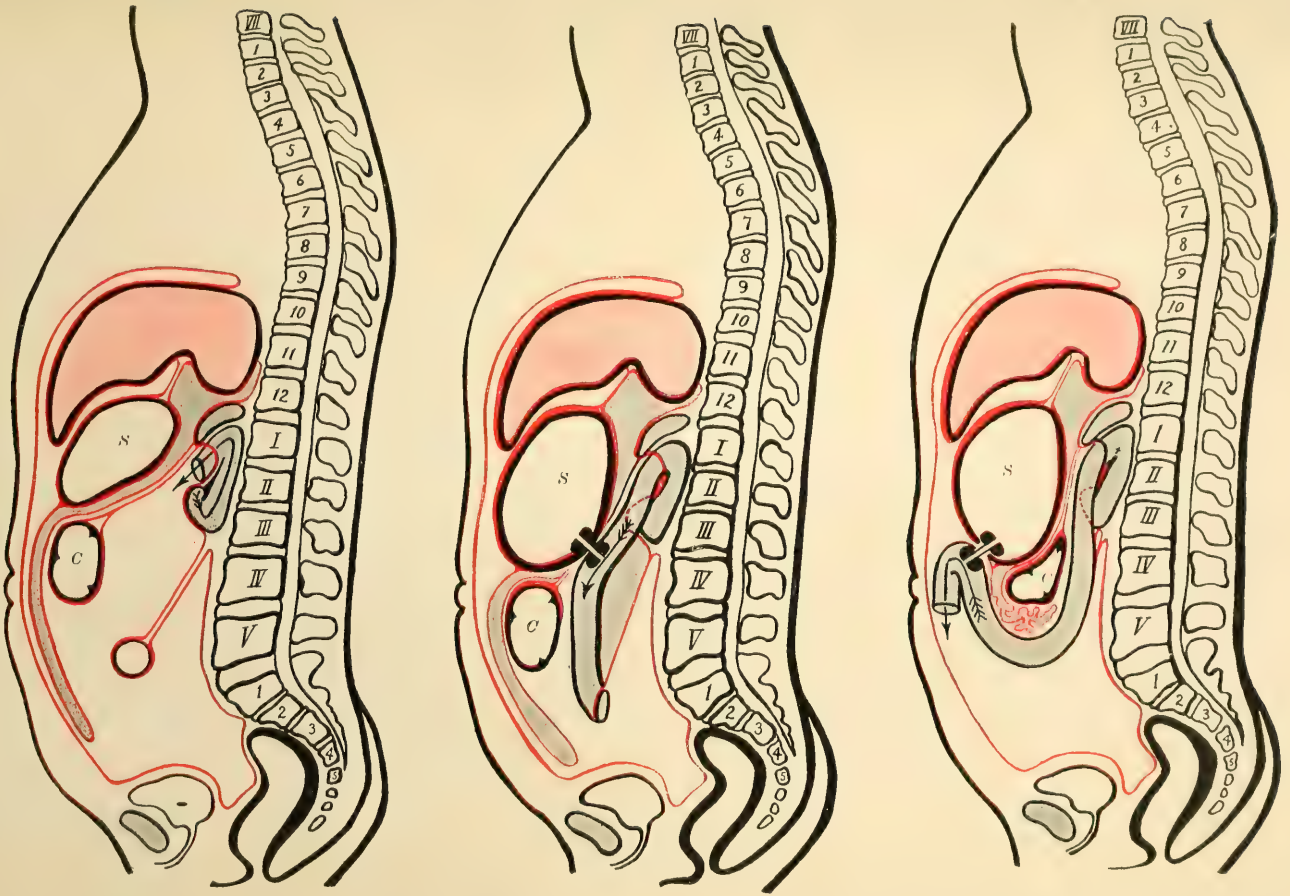


Duodenum and its fossæ. (Huntington.)

lower as applied to the contents of the stomach are of minor importance. The stomach empties itself in the direction of the least resistance, and the force of gravity has comparatively little to do with the process. However, there are other reasons than the one mentioned for making the opening in the stomach in the lowest portion of the organ, and if conditions permit near the pylorus. This is not always possible, and at times one may be compelled to establish the fistula in the fundus

PLATE XIV.

FIG. 1. FIG. 2. FIG. 3.



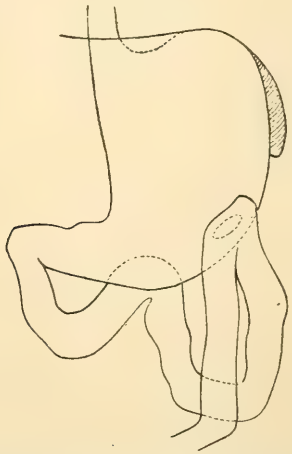
Showing Normal Relations of Stomach, Jejunum, and Transverse Colon, and their Relations in Anterior and Posterior Gastro-enterostomy.

Fig. 1. Normal Relations of Stomach S, Colon C, and Omentum. Arrow in Duodenum Shows Direction of Current. Fig. 2. Retrocolic Gastro-jejunostomy. Fig. 3 Antecolic Gastro-jejunostomy.

of the stomach. The incision through the gastric wall should be parallel to the greater curvature of the stomach.

According to the opinion held at the present time, the point in the jejunum selected for an anterior antecolic anastomosis should be about 50 cm. (20 inches) from the duodenojejunal fold. This distance is required in order to avoid compression of the jejunum or transverse colon. (Fig. 164.) If a higher point in the jejunum were selected, the length of the mesentery might interfere with the free motion of the intestine. The coil of intestine is twisted slightly upon its mesentery so that the peristaltic waves within shall correspond with those of the stomach. (Fig. 165.) The intestine is applied to the stomach in the frontal plane, although Kocher and some others prefer a sagittal plane. (Fig. 166.) If the sagittal plane is chosen, the afferent portion of the

FIG. 165.



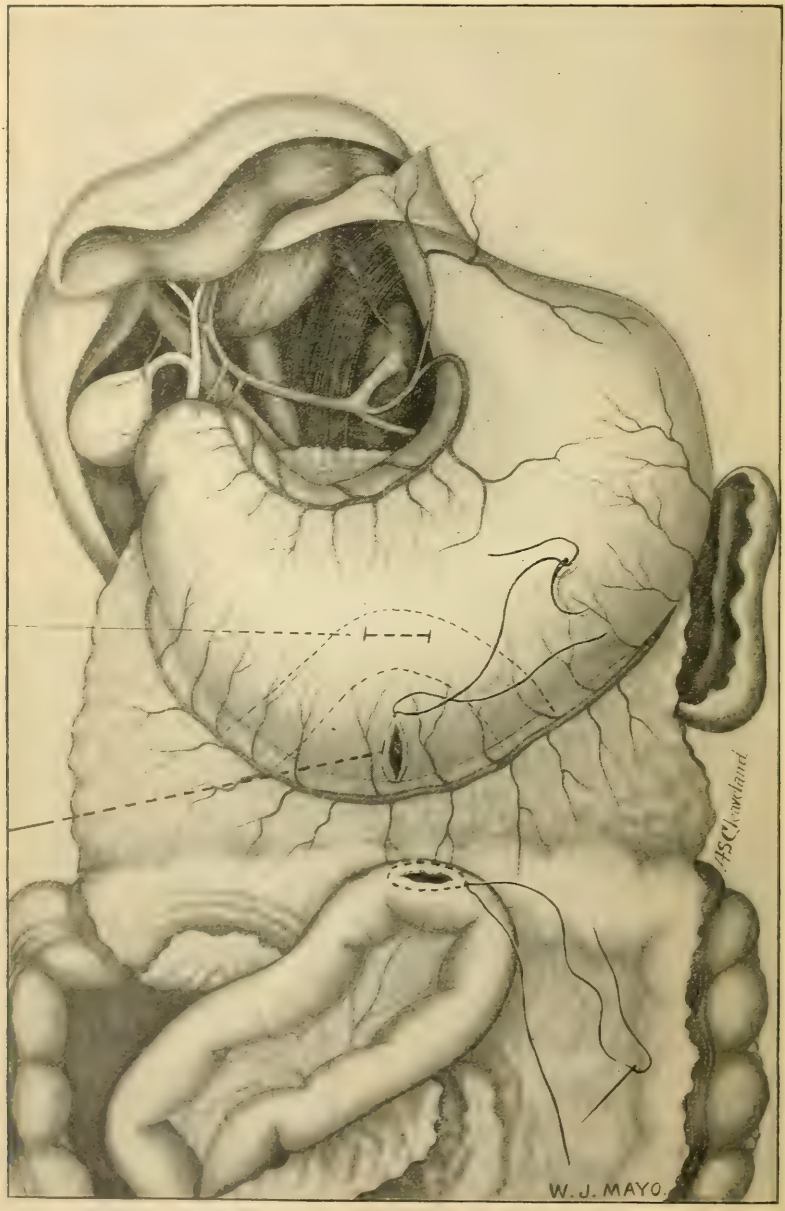
Gastrojejunostomy: intestine arranged in frontal plane so as to secure isoperistaltic action. (Wölfler-Lücke.)

intestinal loop must be posterior and the efferent portion anterior. This point is spoken of later in the discussion of the so-called vicious circle. If the intestine is applied in the frontal plane, the incision in it should be a longitudinal one; if in the sagittal plane, the incision should be transverse, as shown in Fig. 177.

In posterior retrocolic anastomosis the intestinal loop is kept as short as possible, but not short enough to bring tension upon it. Difference in direction of peristaltic action of the stomach and intestine which may then exist produces no unpleasant effect. If the afferent portion of jejunum is short, and if, as usually happens, the stomach is dilated, the afferent portion of the intestine extends obliquely downward from the duodenojejunal fold to the point of anastomosis with the stomach, while the efferent portion extends vertically downward. (Figs. 167 and 168.) This relation facilitates the discharge of gastric contents into the efferent portion of the small intestine; but here, too,

it must be remembered that gravity has little effect upon the current of the intestinal canal, the flow being in the direction of the least

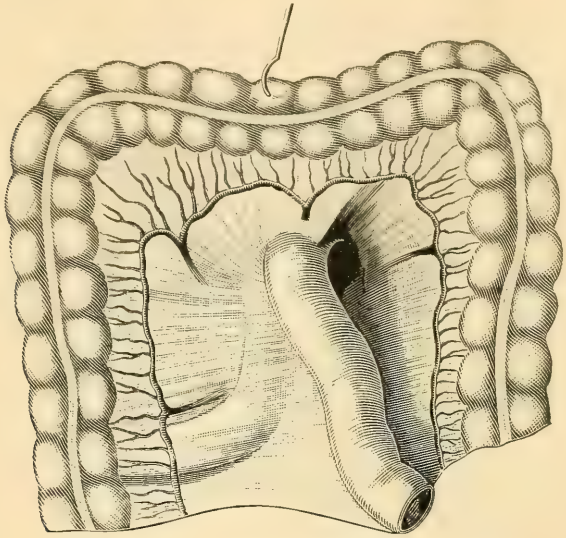
FIG. 166.



Proper and improper sites of opening in stomach in gastro-enterostomy: *a*, proper position, leaving no pouch; *b*, improper position, forming an intragastric pouch. (Mayo.)

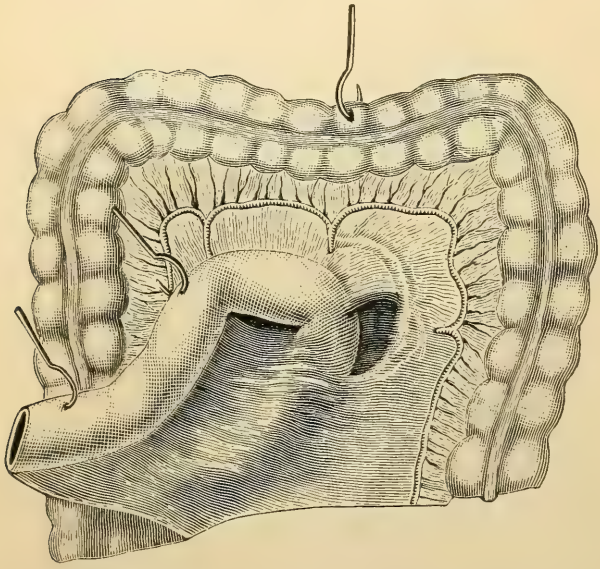
resistance. A free opening is therefore very important in all anastomoses. (Figs. 169–173.)

FIG. 167.



Duodenal and jejunal attachments. (Hartmann.)

FIG. 168.

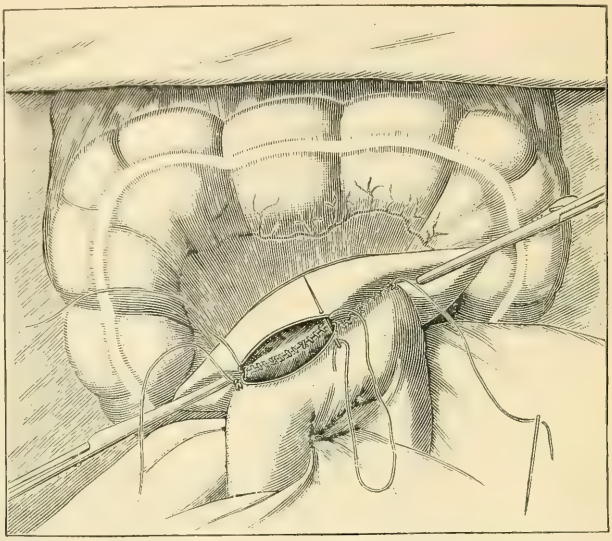


Duodenal and jejunal attachments as they appear when the jejunum is drawn to the right for gastro-enterostomy. (Hartmann.)

There have been numerous modifications suggested of the methods of performing gastro-enterostomy for the reason that no single method

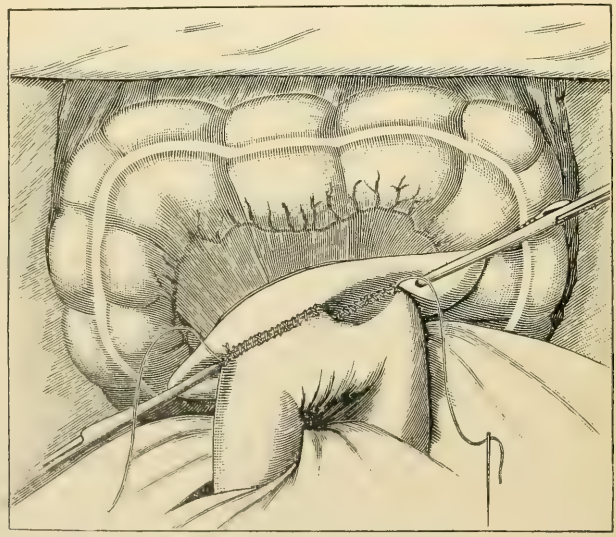
is adapted to every case, nor is any method wholly free from the various unpleasant complications which may arise after this operation. The

FIG. 169.



Posterior gastro-enterostomy: posterior part of serous suture inserted; mucous suture half completed. (Hartmann.)

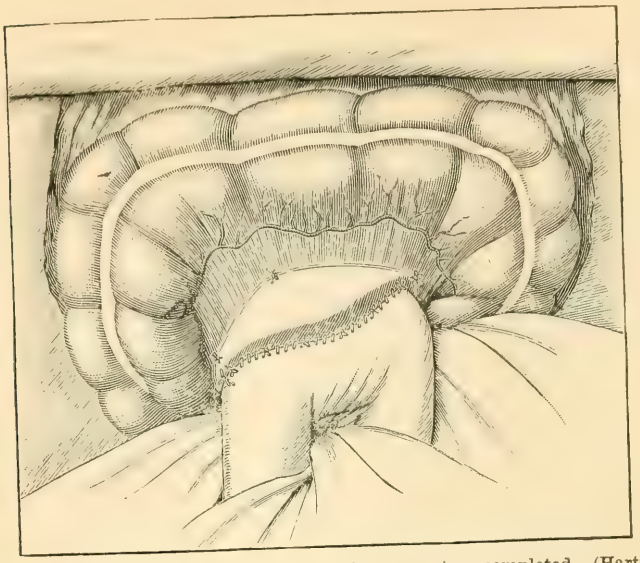
FIG. 170.



Posterior gastro-enterostomy: mucous suture completed. (Hartmann.)

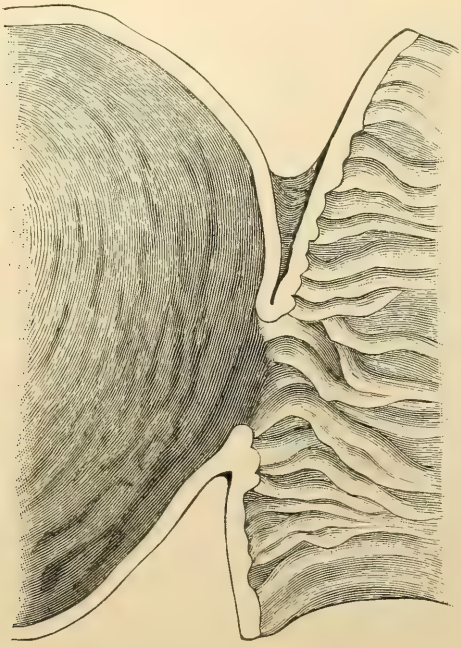
most of these complications are here mentioned. The transverse colon may give rise to trouble, but only in antecolic anastomosis; for then it

FIG. 171.



Posterior gastro-enterostomy: anterior half of serous suture completed. (Hartmann.)

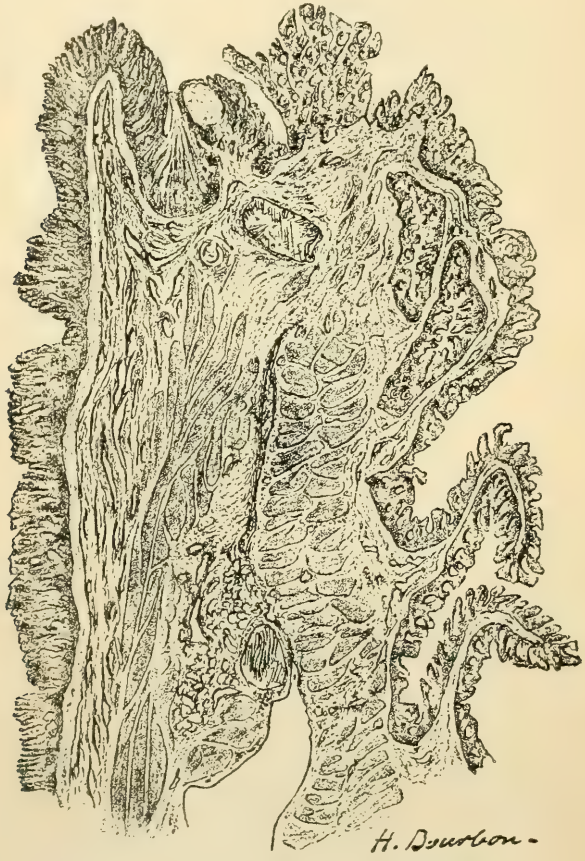
FIG. 172.



Posterior gastro-enterostomy: specimen from autopsy, three months after operation. (Hartmann.)

may compress the loop of jejunum or its mesentery and give rise to ileus. For this reason the loop of small intestine should not be too short. If the point selected for anastomosis is 50 cm. (20 inches) away from the duodenum, trouble of this sort is not likely to follow. After the patient recovers from the operation and goes about, the weight of the transverse colon and omentum, especially if the patient grows stouter, may press upon the anastomosing loop and give trouble. This

FIG. 173.



Posterior gastro-enterostomy: microscopical section three months after operation. (Hartmann.)

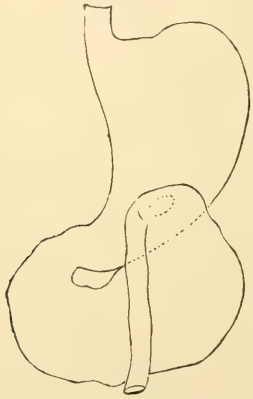
complication, too, can be avoided by utilizing a suitably placed loop of intestine. If this complication is anticipated at operation, the omentum may be split or a wedge-shaped portion of omentum (base upward) may be resected in order to give plenty of room for the small intestine.

The anastomotic opening may contract in time, or close completely. This complication has been observed after all methods, but especially when a Murphy button is used. The exact approximation of the mucous membranes of the stomach and intestine is the best

means of avoiding subsequent contraction. Narrowing of the intestinal lumen may take place in another way if the incision in the intestine is made too long. The intestinal lumen is always somewhat narrowed by anastomosis; but if too much of the circumference of the bowel is used up in the formation of the anastomosis, it will be difficult for the contents of the stomach to pass into the intestine and a vicious circle will be produced.

The formation of a vicious circle was previously much feared as the result of antecolic gastrojejunostomy. If such an anastomosis is successful, the afferent loop will discharge bile and pancreatic juice, but only a small portion of the gastric contents. In certain cases the contents of the stomach pass into the afferent loop and back into the

FIG. 174.



Dilatation of the afferent portion of the intestine following gastro-enterostomy.

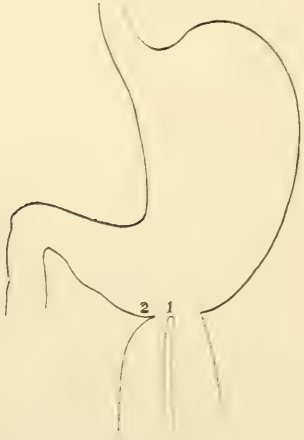
stomach without escaping through the efferent loop. Under such circumstances the afferent loop will be found greatly distended, while the efferent loop and the rest of the small intestine are collapsed and empty. (Fig. 174.) The stomach under such circumstances contains bile and pancreatic juice in addition to its normal contents.

The vicious circle is a form of ileus which may develop, as previously described (page 228), as a result of laparotomy. It rarely produces marked symptoms before the third day. It is true the vomiting may continue from the time of operation, but this is usually ascribed to the anæsthetic. If it persists and signs of peritonitis are not present, one should think of the possible existence of a vicious circle. The vomitus is simply bilious if there is no gangrenous material from the carcinoma. The local condition is characteristic. The duodenum and the distended stomach can often be made out in the epigastrium while the rest of the abdomen is empty. Tenderness even in the region of the stomach is not a prominent symptom. The urine is scanty and concentrated on account of the suspension of intestinal absorption. If a stomach-tube is passed, a great quantity of fluid (sometimes more than two quarts) well mixed with bile and containing

more or less blood will be obtained. The distention of the epigastrium will be at once relieved and the vomiting will cease, but both of these symptoms will gradually reappear. If the vicious circle is not by some means overcome, the strength of the patient will be exhausted in from five to ten days. There are cases in which spontaneous recovery has taken place. This is facilitated by periodic relief of the stomach with a stomach-tube. If the patient does not improve very much in four or five days, the abdomen must be opened and the obstruction either removed or avoided as described below.

The vicious circle may be due to a faulty attachment of intestine and stomach. This does not mean necessarily that the direction of peristalsis in the two organs is not the same. It may be produced by other causes; for example, by the attachment of the jejunum too high

FIG. 175.



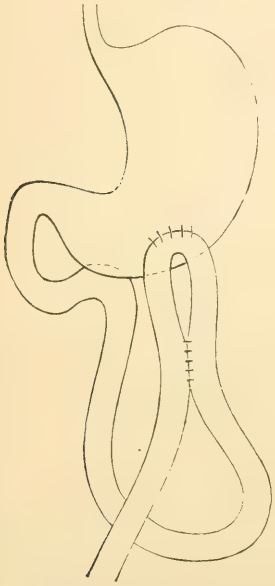
Formation of valves in gastro-enterostomy: 1, intestinal valve: 2, right-sided gastro-intestinal valve.

up. (Fig. 174.) The stomach is drawn forward during the operation; at the close of the operation the stomach draws back into its normal position and gives to the attached loop of intestine a somewhat vertical position. This brings the loop of intestine more into the frontal plane, and the anastomosis, which is now nearly vertical, is freely open into the afferent loop, but is kinked at the efferent. When the afferent loop begins to distend, it presses more and more against the efferent loop and so increases the obstruction.

Obstruction may be due to valvular formation. Immediately after operation the afferent and efferent portions of the loop lie side by side and the walls between them make a sort of partition which the stream of feces tends to press toward the efferent portion and thus reduce the size of its lumen. (Fig. 175.) Numerous attempts have been made to prevent this valvular action, but as far as known without much success.

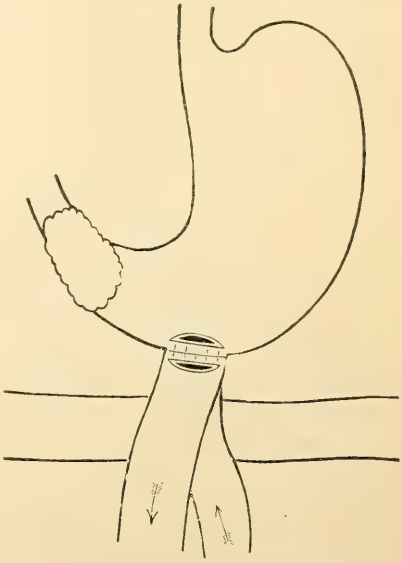
The horizontal attachment of the intestinal loop has sometimes resulted in the formation of a valve between the stomach and attached portion of the intestine. Such valvular action would scarcely take place by pressure upon the afferent loop, and if it did so, it would be of no consequence; but when the stomach contents press down the valve upon the efferent loop the alimentary stream may be blocked. In order to avoid this, Kader suggested attaching the loop of intestine high up upon the stomach and making the anastomosis in the efferent portion lower down. Mikulicz and Czerny overcome the difficulty by a gastro-enteroplasty on the principle of pyloroplasty.

Fig. 176.



Gastro-enterostomy with entero-anastomosis according to Braun.

Fig. 177.



Gastro-enterostomy according to Kocher.

Abnormal relaxation of the stomach and intestine, a result perhaps of conditions following operation, favors the development of a vicious circle. In some cases this relaxation appears to be the whole cause of the faulty emptying of the stomach.

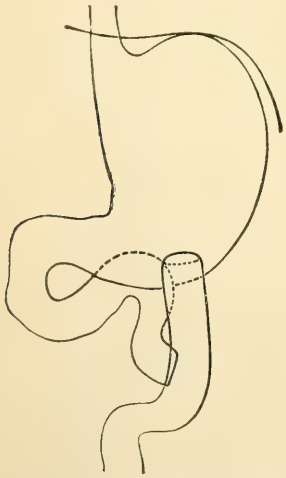
Probably the most frequent cause of a vicious circle is the formation of a spur or valve. Why this gives no trouble in some cases, while in others it completely obstructs the bowel, may depend upon other circumstances.

Three other complications which may follow gastro-enterostomy are twisting of the loop of small intestine due to a faulty technic; the result will, of course, be ileus. Twisting and kinking of other portions of the intestine have also followed gastro-enterostomies, as well as incarceration of another intestinal loop in the imperfectly closed opening

made in the mesocolon in retrocolic anastomosis. The intestine has also become strangulated by slipping in beneath the bridge of jejunum which is always caused by every anastomosis whether antecolic or retrocolic. This produces symptoms which are usually due to compression of the root of the mesentery rather than to incarceration of the intestine.

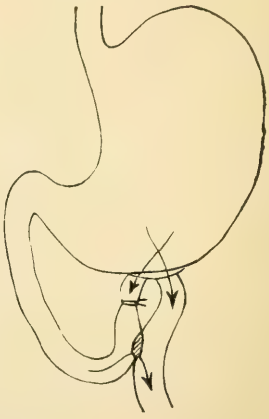
The vicious circle and other complications of gastro-enterostomy are much commoner after an ordinary antecolic anastomosis than after a well-performed retrocolic anastomosis. This has led many operators to prefer the retrocolic method, but the simplicity of the antecolic method gives it a certain advantage which should not be lost sight of.

FIG. 178.



Gastro-enterostomy according to Wölfler and Roux.

FIG. 179.



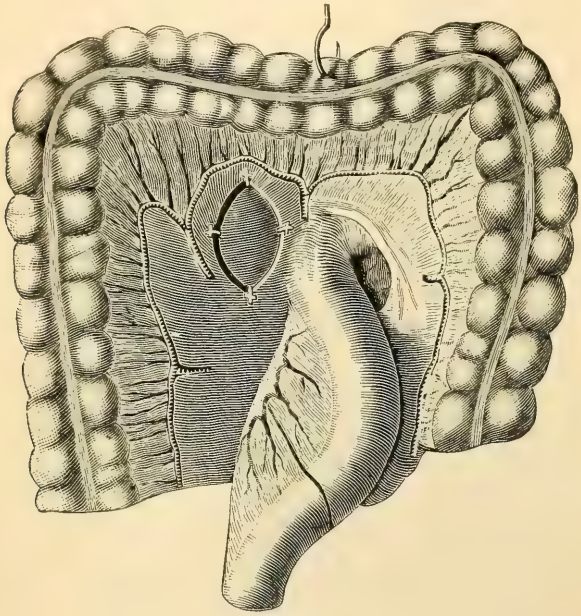
Gastro-enterostomy according to Chaput.

This is especially true in cases of contracted and only slightly movable stomach. There is another step in the technic of an antecolic operation which at least puts it on a plane with the retrocolic method in point of freedom from post-operative complication. Reference is made to the establishment of communication between the ascending and descending portions of the intestinal loop, as recommended by Braun and Jaboulay. (Fig. 176.) Mikulicz always includes this entero-anastomosis in operating upon patients in whom atony or dilatation of the stomach or some other condition indicates the possibility of vicious circle. The additional time required for this step in the operation is not more than six to ten minutes.

Other surgeons have sought in various ways to prevent the formation of a vicious circle. Hacker narrows the entrance to the afferent portion of the intestine by suture. Chlumsky twists the afferent portion through 180 degrees before attaching it to the stomach. Kocher and others try to prevent a return current into the afferent loop by the formation of a valve. (Fig. 177.) Kocher does this by

folding into the lumen of the afferent intestine some of its own wall. Wölfler divides the loop of jejunum and implants the efferent portion in the stomach and then implants the afferent portion in the side of the efferent portion. This is the so-called Y-gastro-enterostomy. Roux performs the same operation, except that he does it behind the colon instead of in front. (Figs. 180, 181.) Chaput performs gastro-enterostomy and entero-anastomosis, and then divides the afferent portion of intestine between these two anastomoses and sutures the cut ends blindly. (Fig. 179.)

FIG. 180.



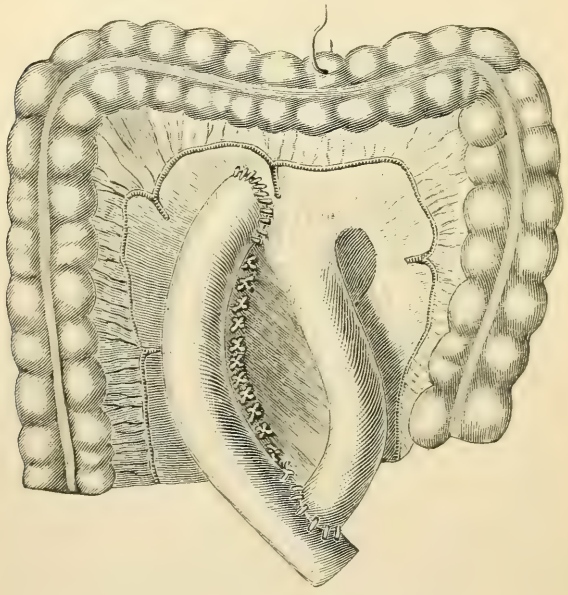
Roux's Y-gastro-enterostomy. Lines of incision.

What has been thus far stated on the subject of gastro-enterostomy applies to anastomosis by suture. This is an operation in which the Murphy button can be used with advantage.

The use of the Murphy button seems to prevent the formation of a vicious circle. This point is of great theoretical interest as indicating that the vicious circle is usually due to a valve. As the free passage of fluid is secured for at least eight days through the button, the patient will have passed the critical period before it is possible for the valve to begin to act, and by the time the button is loosened and passed on, the current in the new direction will be already well established. Mikulicz therefore employs the button for gastro-enterostomy, especially upon patients with malignant disease, for whom the operation should be made as brief as may be, while he employs a suture upon patients with beginning pyloric stenosis, adding an entero-anastomosis to the gastro-enterostomy.

Mikulicz's technic of antecolic gastro-enterostomy is as follows: An incision 10 or 15 cm. (4 to 6 inches) in length is made in the epigastrium or slightly below it. The omentum and transverse colon are raised in the left hand, while the right hand is passed to the root of the mesentery, and the fingers, beginning at the duodenum, seek out the first coil of jejunum. He who has had little practice in this should make certain by sight that his fingers have selected the first jejunal loop. A point about 50 cm. (20 inches) from the duodenum is selected and the bowel is held by an assistant in such a position that its peristaltic action shall parallel that of the stomach. A suitable portion of the stomach is then chosen and the organ is brought forward if possible.

Fig. 181.

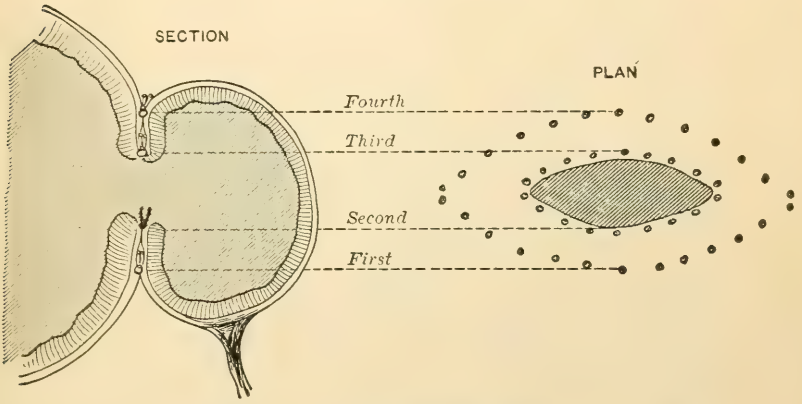


Roux's Y-gastro-enterostomy. Suture complete.

The parts to be sutured are then temporarily tamponed so that the rest of the peritoneal cavity is protected. The intestine in a line near its mesentery is sutured to the stomach for a distance of 5 or 6 cm. (2 to 2.4 inches). This is done with a continuous Lembert suture. (Figs. 105–108.) This suture, although inserted first, is the posterior half of the external or serous suture. (Fig. 182, *first.*) The line of suture upon the stomach is not exactly horizontal, but extends from the left side upward and to the right at an angle of about 45 degrees. When the stomach is replaced, this suture-line will be horizontal. Both ends of the thread are left long so that they may be fastened to the anterior half of the serous suture when this has been inserted. A piece of gauze with a slit cut in it as long as the suture-line is placed over it and gauze compresses

are placed on either side, so that no drop of gastric or intestinal contents shall escape to soil the peritoneum. The stomach and intestine are then opened 2 or 3 mm. (0.1 to 0.2 inch) from the suture-line. These incisions are from 0.5 to 0.75 cm. (0.2 to 0.3 inch) shorter than the suture-line at either end. All bleeding vessels must be seized and ligated with fine catgut, as it is not safe to trust to their compression by suture. Gastric and intestinal contents are wiped away. Special clamps and other contrivances to compress stomach and intestine and so prevent soiling of the wound are unnecessary if the stomach is previously empty and the operator commands the services of a good assistant. A continuous suture through all the layers of both stomach and intestine is next inserted. This suture is begun in the middle of the external suture and continued until nearly half of the anastomosis is completed. (Fig. 182, *second.*) A second continuous

FIG. 182.



Showing application of sutures in gastro-enterostomy. (Richardson.)

suture is begun at the same point as the first and continued in the opposite direction until nearly the whole circumference of the anastomosis has been sutured. The thread is then tied. Both knots and both threads will thus rest within the lumen of the bowel. (Fig. 182, *third.*) The gap which remains is closed by two or three interrupted stitches which must be knotted externally. As these are tied the mucous membrane is inverted. It remains only to complete the external or serous suture, beginning where it was left off before the bowel was opened. (Fig. 182, *fourth.*)

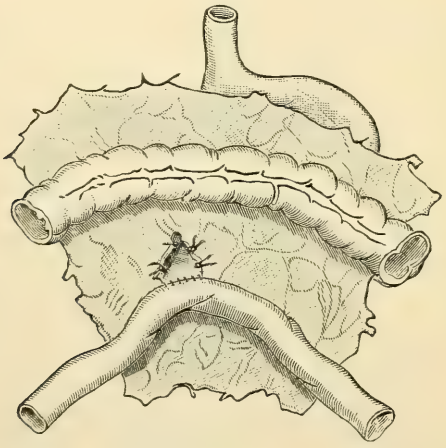
If an entero-anastomosis is needed, it is carried out in exactly the same way at a point 10 or 15 cm. (4 or 6 inches) away from the gastro-enterostomy. The incision for this purpose does not need to be more than 2 or 3 cm. (0.8 or 1.2 inches) long.

If a Murphy button is employed, it is inserted in the manner described on page 405, the male portion being placed in the intestine and the female in the stomach.

In performing a retrocolic gastro-enterostomy the omentum and

transverse colon are raised upward and a sagittal opening is made through the transverse mesocolon in a manner to avoid wounding the large bloodvessels. The posterior gastric wall is brought to the opening and fastened there by three or four catgut stitches. (Fig. 183.) An anastomosis is then established between the stomach and the jejunum at a point as near to the duodenum as may be without bringing tension upon the parts. This anastomosis may be by suture or by the button. The vicious circle is less likely to follow if the anastomosis is at a point near the duodenum. Entero-anastomosis is unnecessary. When Mikulicz performs gastro-enterostomy behind the colon, he does not draw the stomach out to the transverse mesocolon, but passes the jejunum through the slit in the mesocolon until it reaches the stomach. The mesocolon is then stitched to the jejunum and not to the stomach.

Fig. 183.



Posterior gastric wall stitched to mesocolon.

Resection of the Stomach.—The principal reason for resection of a portion of the stomach is the existence of a tumor in its wall. Such tumors are for the most part carcinoma. It occasionally happens that resection is necessary on account of gastric ulcer or some of its sequelæ. For the sake of clearness the following definitions are given in connection with Fig. 184.

Excision is the removal of a portion of the stomach less than its circumference.

Resection is the removal of a larger or a smaller portion of the whole circumference of the stomach.

Extirpation is the total removal of the stomach from the œsophagus to the duodenum.

Excision.—If a portion of the stomach is excised, it should be either a sector (Fig. 184, 6) or a segment (Fig. 184, 5). The removal of an irregular-shaped piece is to be avoided in the interest of a simple suture-line. If a sector is removed, the suture is transverse; and if a

segment is removed, it is longitudinal unless this would narrow the lumen of the organ too much. In that case it is to be made transverse.

Resection.—The pyloric portion of the stomach is the usual site of resection. The upper margin of carcinoma of the stomach may vary from the cardia to near the pylorus, but the lower margin is pretty constantly just beyond the pylorus. Only in rare cases is there a normal gastric wall between the tumor and the pylorus. It is possible to make the line of resection as low down as the entrance of the biliary and pancreatic ducts, although this is seldom necessary.

The numerous methods of resection which have been proposed vary chiefly in the suture of the wound. Thus the duodenum may be united to the stomach, or it may be closed and an anastomosis made between the stomach and jejunum.

FIG. 184.

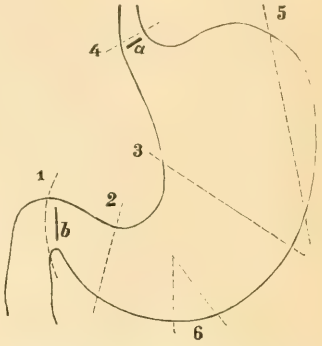


Diagram of the stomach for operative purposes; *a*, cardia; *b*, pylorus; 1-2, resection of the pylorus; 2-3, resection of the body of the stomach; 1-4 extirpation of the stomach; 5, excision of a segment, or of a sector 6.

Billroth developed the operation of gastric resection and carried it out successfully for the first time in 1881.[1] His method at that time

FIG. 185.

Resection of the pylorus according to Billroth's first plan.

FIG. 186.

Resection of the pylorus according to Kocher.

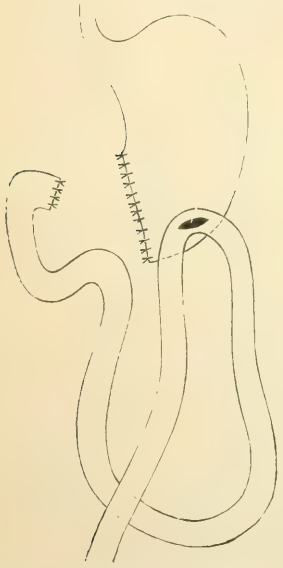
was to unite the duodenum and stomach as shown in Fig. 185. Kocher

[1] The first resection of the stomach was performed by Péan, in 1879; the second by Rydygier, in 1880. Both of these patients died from the operation.

closed the opening in the stomach and implanted the duodenum in its posterior wall. (Fig. 186.)

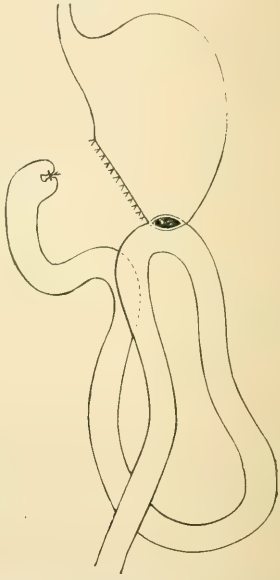
Either because a large portion of the stomach has been resected or for some other cause it may be impossible to unite the duodenum with the remains of the stomach. Under such circumstances Billroth performs antecolic gastro-enterostomy and then resects so much of the stomach and duodenum as may be necessary, closing each opening blindly. (Fig. 187.) Either step in the operation may be performed first. A portion of the wound in the stomach may be utilized for anastomosis with the duodenum. (Fig. 188.) While the method first

FIG. 187.



Resection of the pylorus according to Billroth's second method.

FIG. 188.



Resection of the pylorus according to Krönlein and Mikulicz.

employed by Billroth is still in use by Mikulicz and other surgeons, the tendency to cut wide of a malignant tumor often makes it impossible to approximate the stomach and duodenum without too great tension.

The technic of resection of the pylorus is as follows: The incision is an epimesogastric one, 15 to 20 cm. (6 to 8 inches) long. The pyloric portion of the stomach is brought forward and surrounded with pads, and the size of the tumor and the presence of affected lymph-glands determined. If it appears that the duodenum cannot be sutured to the stomach, the proper loop of jejunum is selected for anastomosis and isolated by gauze, and the direction in which it is to be placed is marked by passing threads through its mesentery. This is done at this stage of the operation so that the peritoneal cavity need not be searched through after the stomach has been opened.

The gastrocolic ligament is ligated in sections and divided. The

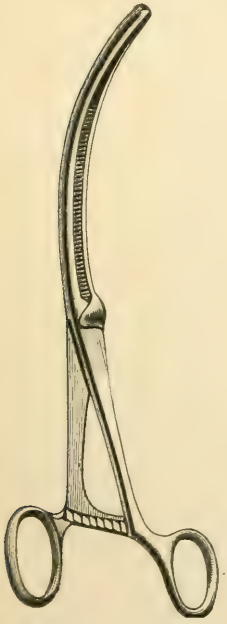
portion next the stomach may be secured by clamps instead of ligatures in order to save time. If this ligament is much thickened by fat, grooves should be pressed in it by a strong clamp before the ligatures are applied. (Fig. 112.) Sometimes affected lymph-glands are embedded in this ligament. If so, these should be removed. (Compare the description of the spread of cancer in the section on Gastric Carcinoma.)

If the mesocolon is involved in the disease, a portion of it must be removed. If this necessitates ligation of the median colic artery, the central portion of the transverse colon will be deprived of its chief blood-supply, and not receiving sufficient nourishment through the right and left colic arteries it may become gangrenous. This risk of gangrene will be increased if the small anastomosing branches of the artery are also ligated close to the colon. If such a serious condition is recognized when the abdomen is opened, the operation had better be abandoned. If it is not recognized until after the resection has been performed, it will be necessary to resect also the central portion of the transverse colon. This had best be done in two steps. In spite of this complication several successful operations of this sort have been reported. Usually the appearance of the colon during the operation will indicate an impending necrosis. Its wall loses its normal vascular appearance and it appears like a flabby empty sac which soon has a disagreeable odor like that noticed at autopsy. The lesser omentum is next divided. Search should be made in it as high as the cardia for affected lymph-glands. If any are found, it is best to remove the entire membrane. This step in the operation is made easier by the prolongation of the incision as far as the ensiform cartilage. The vessels of the small omentum should be ligated with great care since torn or divided arteries and veins may retract and be found again only with difficulty. If the tumor has involved lymph-glands in the neighborhood of the pancreas or the pancreas itself, the removal must include a portion of this organ if radical operation is persisted in. Hemorrhage from the pancreas is troublesome, but can be controlled by mass ligatures and deep sutures. Ligation of the pancreatic artery produces necrosis of the pancreas. In this region one may easily wound other large vessels, such as the splenic artery or vein, the hepatic artery, large branches of the portal vein, etc. In exposing the pylorus and the upper portion of the duodenum the surgeon should be on the lookout for the common bile-duct, especially if old cicatrices or malignant tumors have altered the normal relations of the parts. When the portion of the stomach to be resected has been freed all around, the duodenum is crushed transversely with the enterotribe, 1 to 2 cm. (0.4 to 0.8 inch) below the edge of the tumor, and ligated with silk. (Fig. 113.) About 1 cm. (0.4 inch) above this ligature a second one is applied to control the intestinal contents and the duodenum is divided between these ligatures after the parts have been protected by gauze. The stump of the duodenum is closed by a purse-string suture. (Fig. 114.)

If the conditions are such that the duodenum and stomach can be

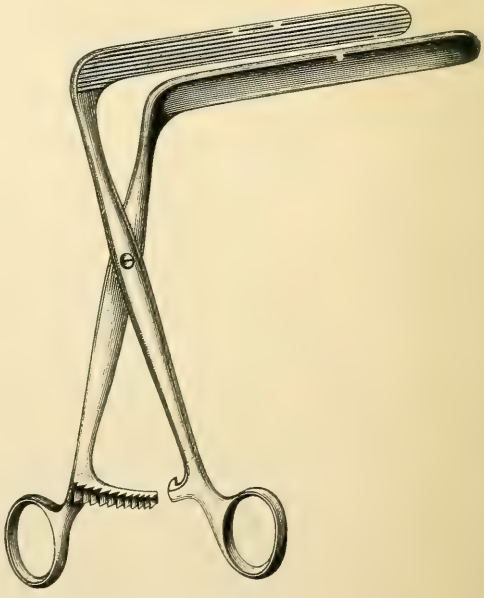
united, the former is compressed with a special clamp instead of with the enterotribe. (Figs. 189 and 190.) Pressure-clamps are also placed upon the stomach 5 to 10 cm. (2 to 4 inches) above the margin of the tumor. The upper clamp must be 3 to 5 cm. (1.2 to 2 inches) from the line of incision. The affected portion of the stomach is then resected and removed. Asepsis in operations upon the alimentary canal is preserved, first, by a careful temporary tamponade; second, by an immediate sponging up of gastric or intestinal contents; and third and most important, by the fact that the lumen is either not at all exposed or is exposed for the shortest possible time. The possibility of blind closure of the intestine by means of a purse-string suture without

FIG. 189.



Doyen's intestinal clamp.

FIG. 190.

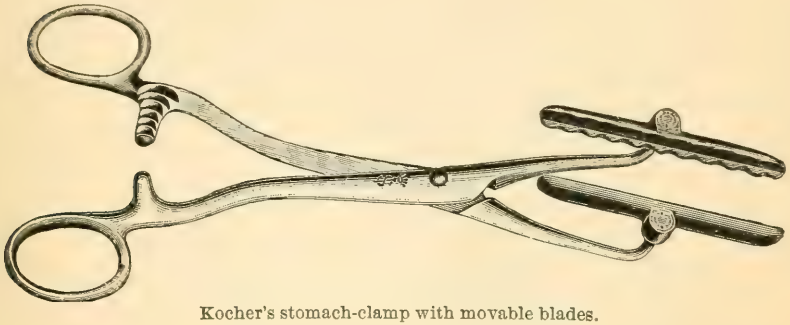


Mikulicz's gastric and intestinal clamp (½ natural size).

the escape of any contents is described on page 403. Under such circumstances the risk of infection is scarcely worth mentioning. This method also prevents hemorrhage. For these reasons it is almost universally employed when the duodenum is to be closed blindly. Doyen also uses the purse-string suture for closure of the stomach even if its diameter in the plane of resection is 10 or 15 cm. (4 or 6 inches). Such a broad wound, however, can be much better closed in another manner. An enterotribe larger than that shown in Fig. 112 is applied to the stomach and mattress sutures are inserted in the groove. The stomach is resected close to this line of sutures. The whole suture-line is then dimpled into the stomach and covered by a Lembert suture. Kocher

clamps the stomach (Fig. 191), and without removing the clamp stitches across its whole breadth just above the clamps with a mattress suture. He then resects the stomach, applies a running suture to the free edges, inverts this and the mattress suture, and covers both in with a Lembert suture. These procedures are only possible in Kocher's operation and in Billroth's second method of operating. (Figs. 186 and 187.)

Fig. 191.

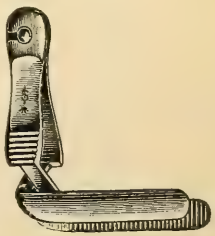


Kocher's stomach-clamp with movable blades.

These closed methods of operating prevent hemorrhage and the escape of gastric contents, but they have the disadvantage that the operator is prevented from inspecting the interior of the stomach, a step which may be of great importance in determining the extent of the carcinoma. For this reason the methods should not be followed in all cases.

Even with the best of intestinal clamps discharge of intestinal secretion and hemorrhage may not be perfectly controlled, hence clamps find their chief use in cases in which the clamped intestine is to be utilized for anastomosis. It is obvious that the clamp must not injure the intestinal wall, and hence it must not press too powerfully. If it does so, it may also occlude some large vessel, which may thus be overlooked and not ligated. Under such circumstances hemorrhage may occur within the stomach or intestine after the suture has been completed and lead to fatal results. A properly constructed intestinal clamp should permit some blood to flow from the larger vessels, which, of course, must be ligated. There are a great number of these clamps on the market. (Fig. 192.) Some surgeons prefer to use a temporary ligature made of silk or a strip of gauze which is passed around the intestine through an opening in the mesentery. Indeed, pressure upon the intestine made by the fingers of the assistant does away with the necessity for any clamp.

Fig. 192.

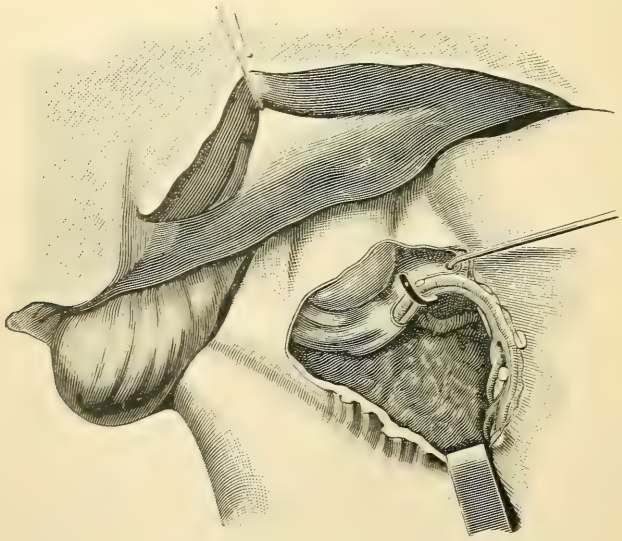


Murphy's intestinal clamp.

When the affected portion of the stomach has been removed, a broad wound in this organ is partially closed by a double row of

sutures until it adapts itself to the duodenum or jejunum. The first suture is applied from within, beginning at the lower curvature; the second one is applied from without. The suture of stomach and intestine must be an exact one, and even with the greatest care the point where the gastric and anastomotic sutures meet is apt to be weak. This extra care prolongs the operation, which is an important point if the resection is an extensive one. A Murphy button may be employed with advantage. The funnel shape of the stump makes it almost impossible for the button to fall into the stomach instead of into the intestine. The button is not only adapted

FIG. 193.



Resection of the stomach. Ligation of the coronary artery. (Hartmann.)

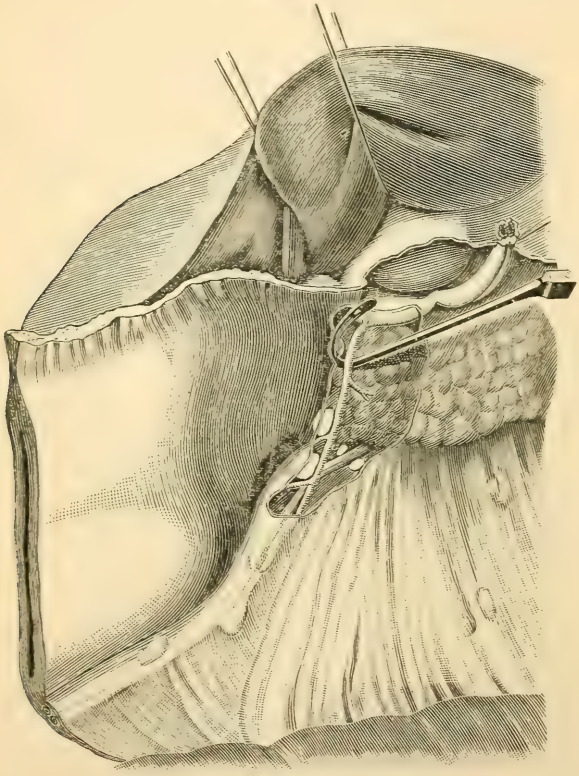
to those cases in which the jejunum is attached to the stomach at a lower portion of the gastric wound, but also to those cases in which operation is performed according to Billroth's first method. (Fig. 185.) In all these cases, however, the operation is simplified if the wound in the stomach is completely closed and a new opening is made for anastomosis of the intestine, provided, of course, that the portion of the stomach which remains is sufficiently large for the purpose. It is a matter of indifference whether the duodenum is implanted in the anterior or posterior wall. In many cases after extensive resection what is left of the stomach is not much more than a narrow tube, and to make a second opening in this for the sake of anastomosis would be inadvisable.

Figs. 193 and 194 show the method of resection advocated by Hartmann.

If a Murphy button is not employed in operating according to

Billroth's first method, the posterior surfaces of the stomach and duodenum are first attached by a number of deeply placed Lembert interrupted stitches. These threads are left long so as to keep the wounded surfaces well in view. They are inserted from within outward and tied. When they are all in place, they may be cut off short. An inner continuous suture is then applied, as in gastro-enterostomy; and finally the serous suture is completed anteriorly. Two or three

Fig. 194.



Resection of the stomach. Ligation of the gastroduodenal artery. (Hartmann.)

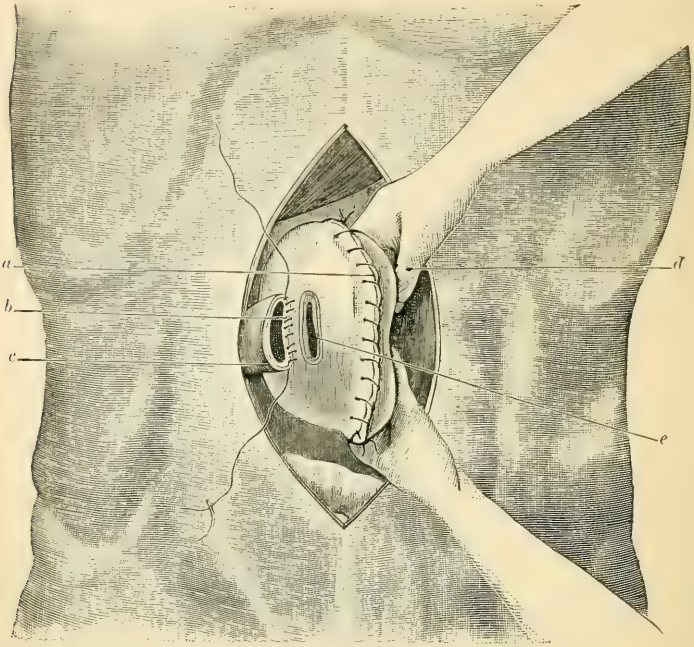
extra sutures are inserted at the point where the gastric suture joins the gastrojejunal one. At the close of every gastric or intestinal suture a little iodoform powder should be dusted upon the suture-line. The abdominal cavity is completely closed. Drainage is inadvisable in these cases since experience has shown that it is likely to produce a gastric fistula. If this occurs, the patient will soon die from starvation.

From this description of the technic of resection of the stomach one can easily follow out the other modifications mentioned. (Fig. 195.)

Extirpation of the Stomach. Gastrectomy.—The technic of extirpation of the stomach is exactly like that of an extensive resec-

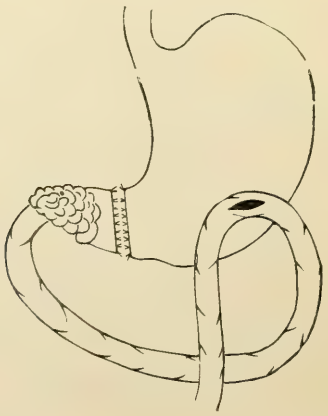
tion of the stomach, except that the necessity for reducing the lumen of the upper extremity no longer exists. The œsophagus and intes-

FIG. 195.



Gastroduodenal implantation. The operation of pylorectomy and gastro-enterostomy (Kocher's method): *a*, continuous serous suture closing the stomach; *b*, post-serous suture between stomach and duodenum; *c*, duodenum; *d*, assistant closing stomach and duodenum by pressure; *e*, opening in posterior wall of stomach.

FIG. 196.



Elimination of the pylorus according to Eiselsberg.

tine are directly united. It should be remembered that if necessary the œsophagus can be brought out through the diaphragm for a distance

of several centimetres. Care should be given to this suture if the œsophagus is not covered with peritoneum. Here too a Murphy button has advantages over the anastomosis by suture. The œsophagus and duodenum will usually be found too far apart for anastomosis, hence the jejunum will be employed. Schlatter was the first to remove the whole stomach with success.

Elimination of the Pylorus.—After every gastro-enterostomy the amount of gastric contents which passes the pylorus is more or less reduced; and gangrenous secretion from a pyloric tumor and contents of the duodenum may enter the stomach after gastro-enterostomy. Therefore Eiselsberg recommends that the stomach be divided above such a tumor and the lumen on either side of the incision closed by suture. Gastro-enterostomy may or may not be previously performed. As far as known, this operation has not yet been performed. The technic is similar to that of resection of the pylorus.

OPERATIONS UPON THE INTESTINE.

Puncture of the Intestine.—Puncture of the intestine through the unopened abdominal wall may be of service as a temporary means of relieving excessive meteorism when one is not in a position to apply a more radical remedy. In rare instances it may be so combined with gastric lavage and irrigation of the colon that a cure results.

There are two objections to puncture of the intestine. The first is that a cannula may not permit the escape of sufficient gas to relieve the condition of meteorism. The second and more important objection is that infectious material escaping from the punctured wound of the intestinal canal may set up an infectious peritonitis. The result of puncture depends not only upon the degree of meteorism, but also upon the contractility of the intestinal muscles. If the intestine is completely paralyzed, for example in well-advanced peritonitis, puncture will relieve only the portion of the intestine immediately in the neighborhood of the cannula; whereas if the muscles of the intestine are still active, the effect of puncture may be far greater. The discharge of gas through so small a tube is naturally slow, so that it must be left in position from a half hour to an hour in order to relieve the patient. To use this instrument satisfactorily requires therefore both time and patience; but under favorable circumstances a great deal can be accomplished by it to relieve the patient of distention. In certain cases time is gained for a radical operation, and in others in which ileus is due to a mechanical obstruction the relief of the distention may be followed by disappearance of the mechanical obstruction.

The risk of infective peritonitis following puncture of the intestine is a real one, particularly if a large canula is employed, or if the intestine is paralyzed so that its muscles cannot contract and close the wound of puncture. If the intestinal wall still possesses some contractile power and the puncture is made with a fine cannula, the risk of escaping intestinal contents is extremely slight.

Puncture of the abdominal cavity with the hope of obtaining fluid for diagnostic purposes is never to be advised unless laparotomy is at once to be performed. This is especially true of puncture of the gall-bladder, since even the finest needle makes a hole from which bile continues to be discharged for a long time.

Intestinal puncture should be made in the linea alba when possible because in this line one is certain not to wound any large vessel. There must, of course, be tympanitic resonance at the point selected for puncture. A sharp hollow needle not attached to a syringe is thrust in at right angles to the surface of the abdomen until gas is heard to escape through it. If the lumen of the needle is stopped by some of the tissues through which it passes, or by feces, the syringe should be attached and gentle aspiration made. When the tension of the abdomen is relieved, the gas escaping more slowly makes no sound, but its presence can be shown by its effect upon the flame of a match or by letting a drop or two of fluid fall upon the outer end of the needle. Usually, too, the gas which escapes has a penetrating odor. The needle should remain in position from fifteen minutes to an hour if the escape of gas continues so long. It is then withdrawn by a quick motion. If the meteorism recurs and a second puncture is required, the needle should be introduced at some other point.

Enterorrhaphy, Enterotomy, Enteroplasty, Enteropexy.—These operations upon the intestine are similar to those performed upon the stomach, and the technic is similar. In order to avoid narrowing the lumen of the intestine all sutures should be made transverse. Even longitudinal wounds should be sewed transversely. The intestinal wall is so flexible that this method of suture is easily carried out and a slight increase in the lumen of the intestine is no disadvantage. In the course of time such a dilatation entirely disappears.

Enteroplasty, which is analogous to pyloroplasty, is called for in the case of cicatricial and other benign stenoses of the intestine and to overcome the effects of a spur or valve. Other more complicated methods are usually employed in the closure of an artificial anus associated with a spur. These will be described later.

Enteropexy or colopexy is an operation sometimes performed for the relief of chronic prolapsed rectum. The sigmoid flexure is affixed to the wall of the pelvis or of the abdomen by a series of sutures.

An enteropexy may be performed in connection with other operations in order to lessen the mobility of the intestine. Thus the sigmoid colon has often been sutured to the abdominal wall in order to prevent a recurring volvulus. Enteropexy may also be employed to prevent a chronic intestinal invagination, especially in children.

Enterostomy.—Enterostomy, or the establishment of a permanent external opening in the intestine, may be performed for either of two objects: for the sake of artificial feeding or for the discharge of intestinal contents. An opening for the first of these two purposes will naturally be made as high up in the intestine as possible (duodenostomy or jejunostomy), while one for the discharge of feces will be made as

low down as possible (ileostomy, colostomy). The difference in purpose has led also to a difference in technic.

Duodenostomy; Jejunostomy.—On account of the anatomical relations only the first portion of the duodenum can be utilized for a permanent fistula, and a high jejunostomy is generally preferable. This may be performed according to the principles of gastrostomy, Witzel's method being the best. (Page 416.) The drainage-tube is placed longitudinally in the efferent portion of the intestinal loop and two longitudinal folds of intestine are sutured over it. If the fistula is only a temporary one, the operator should avoid too great a narrowing of the bowel at this point. Even when the fistula is to be permanent it is necessary to leave sufficient room for the passage along the side of the drainage-tube into the lower bowel of bile, pancreatic juice, and other secretion. The tube therefore must be a slender one, not more than 4 or 5 mm. (0.2 inch) in diameter, and the intestinal folds which are sewed over it should not be too broad.

If jejunostomy is performed simply as a palliative operation when the patient is unable to endure resection of the stomach or gastro-enterostomy or gastrostomy, a median incision in the neighborhood of the umbilicus will suffice; otherwise an incision through the left rectus muscle is preferable.

Maydl is an enthusiastic advocate of jejunostomy, which he performs as follows: Through an incision in the median line below the umbilicus he reaches the highest loop of the jejunum, divides it transversely 20 cm. (8 inches) below the duodenum and implants the upper end in the side of the lower from 20 to 30 cm. (8 to 12 inches) below the point of incision. This anastomosis is made either with suture or with a Murphy button. The cut end of the efferent bowel is freed from its mesentery for a distance of 2 cm. (0.8 inch), passed beneath the skin, or the skin and rectus muscle, and brought out of the second incision through the skin at a distance of 2 cm. (0.8 inch) from the first incision. It is fixed to the skin by a few stitches and the original abdominal incision is completely closed. Albert performs the same operation, except that he makes a lateral anastomosis between the afferent and efferent portions of the jejunal loop and brings the loop itself out under the bridge of skin and rectus muscle and opens it at the end of four days, or sooner if necessary. Mikulicz holds a less favorable opinion of jejunostomy, and performs it only under circumstances in which gastro-enterostomy is impossible or unsatisfactory.

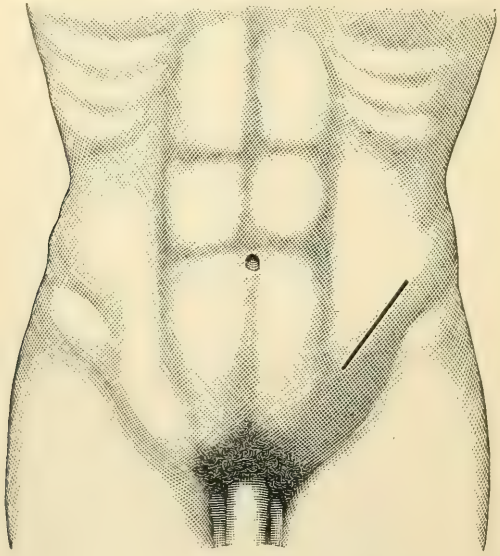
Temporary jejunostomy may be necessary in the case of severe burns of the œsophagus or stomach, or severe hemorrhage of the stomach which cannot be otherwise controlled, and also in case of cicatricial stenosis of the pylorus when the condition of the stomach is such that neither gastro-enterostomy or pyloroplasty is possible, and finally in cases of gastric ulcer so severe that absolute rest of the stomach is necessary to effect a cure.

If the wall of the stomach is found at operation to be so extensively infiltrated with cancer that a gastro-enterostomy is impossible, it is

better simply to close the abdominal cavity rather than to establish an intestinal fistula in the hope of prolonging the patient's life for a few weeks. This condition is by no means comparable to carcinoma of the œsophagus, which can successfully be met by a gastrostomy. Such a patient has usually little or no pain except when he attempts to swallow, and he enjoys a fair degree of health for some months after gastrostomy, while a patient with extensive carcinoma of the stomach suffers from almost continuous pain irrespective of his lack of nutrition, and his cachexia cannot be overcome by any artificial means of introducing nourishment.

There is, too, a great difference between artificial feeding through a fistula of the stomach and that through an intestinal fistula. In the first case, gastric digestion is more or less preserved and the physiologic

FIG. 197.



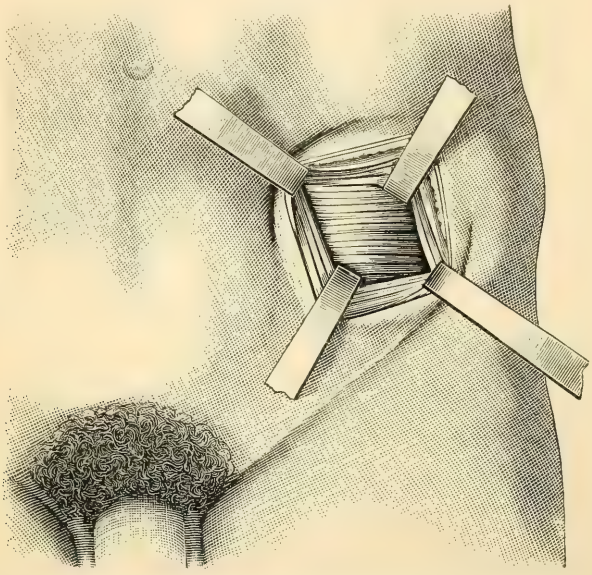
Incision for inguinal colostomy. (Hartmann.)

relations between the gastric juice on the one hand, and bile, pancreatic juice, and intestinal juice on the other, enable the patient to get the good of his food. Furthermore, the stomach acts as a reservoir for the food so that nutrition can be provided for with a limited number of meals. All these conditions are changed in jejunostomy, and it is found to be extremely difficult to maintain the health of the patient through a jejunal fistula. This difficulty is much increased by the presence of a carcinomatous stomach. It is therefore not surprising that jejunostomy is less satisfactory than gastro-enterostomy under similar conditions.

Ileostomy; Colostomy.—Ileostomy is performed only when the obstruction to the fecal stream exists in the cæcum or above it. There

are two forms of fecal fistula. There is a fecal fistula, in the narrower sense of the word, from which escapes only a portion of the intestinal contents, while the rest passes by the natural channels. Then there is a fecal fistula that is called an artificial anus, through which the whole fecal discharge reaches the outer world. There are all degrees between the smallest fistula and an artificial anus. A lateral fistula is established with the object of relieving the intestine; an axial fistula, if it is desired to keep the lower portion of the intestine entirely free from fecal matter, or if the fistula is to remain throughout life.

Fig. 198.



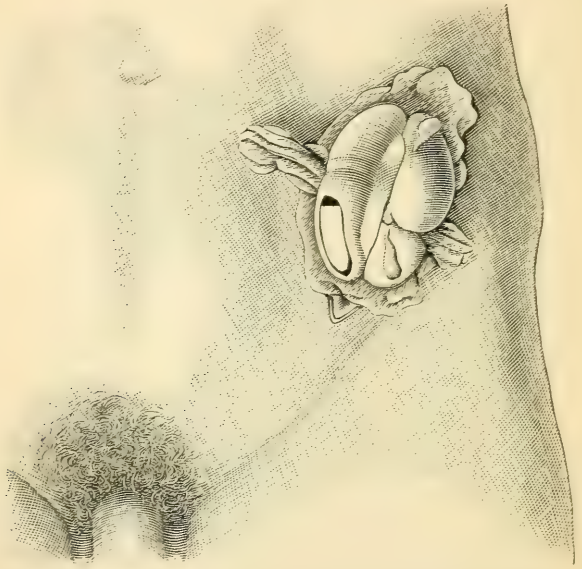
Inguinal colostomy. Separation of muscular fibres. (Hartmann.)

For the sake of cleanliness it is well to place the fistula in the lower portion of the abdomen not far from the inguinal fold. (Figs. 197–199.) The rest of the surface of the abdomen is thus kept free from defilement with feces, and it is easier for the patient to look after the fistula than when it is situated elsewhere. Furthermore, apparatus having for its object the retention of feces works more satisfactorily in this region.

In general there are two portions of the intestine suitable for the establishment of a fecal fistula, namely, the region of the ileocæcal valve for obstruction existing anywhere in the large intestine, with the exception of the sigmoid colon and rectum, and the region of the sigmoid for obstruction existing in the sigmoid or rectum. In the first case the fistula will be established either in the cæcum or in the adjacent portion of the ileum. In the second case it will be situated in the sigmoid or in the lowest portion of the descending colon. In a few cases a fistula is made in some other situation; for example, if the

abdomen is opened low down in the median line, and for some reason it is desired to use the portion of intestine which presents itself in the wound. Only the lowest portion of the ileum should be utilized for a fecal fistula, since the risk of death by starvation is greatly increased if the fistula is only a short distance removed from the ileocæcal valve. (See section on Intestinal Fistula, page 281.)

Fig. 199.



Inguinal colostomy. Completion of operation. (Hartmann.)

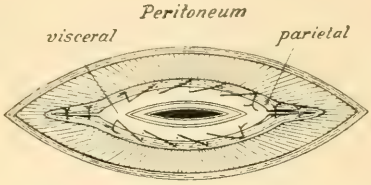
Establishment of a Fecal Fistula.—An incision 5 to 10 cm. (2 to 4 inches) long is made parallel to Poupart's ligament, and 3 to 4 cm (1.2 to 1.6 inches) above and in front of the anterior superior spine. As soon as the peritoneal cavity is opened, the portion of intestine in which the fistula is to be made is brought out of the wound.

If meteorism is marked, as so often happens in these cases, it may be difficult to find a proper intestinal coil because the much dilated coils of small intestine crowd into the wound. The determination of the proper coil usually rests upon the recognition of large intestine. The thick longitudinal bands which normally distinguish large intestine may be obscured by congestion and dilatation. Under such circumstances the appendicæ epiploicæ are the best distinguishing marks. Another sign characteristic of the large intestine is the direction of its meson. One should not trust to the length of the meson, since the sigmoid mesocolon may be very long. But the mesons of the ascending and descending and sigmoid portions of the colon, all spring from the lateral walls of the abdomen, a fact which can always be readily determined by the examining finger. The mesentery, on the other hand, springs from the spinal column high up. If a loop of ileum is

to be used for the fistula, it should be chosen by estimating the distance from the cæcum.

The opening in the intestine should be made opposite to the mesenteric attachment. The intestine is fixed in the wound by a continuous serous suture of the visceral peritoneum to the parietal peritoneum and transversalis fascia. The space thus surrounded by suture should

FIG. 200.



Showing the establishment of a fecal fistula.

measure 3 to 4 cm. (1.2 to 1.6 inches) in length and 1.5 to 2 cm. (0.6 to 0.8 inch) in breadth. If the wound in the parietal peritoneum is longer than this, it should be reduced in size by a couple of interrupted sutures. (Figs. 200–202.)

If there is no need to hasten the opening of the bowel, this step in the operation is postponed for one or two days, less for the protection

FIG. 201.

Artificial anus. Suture of bowel to peritoneum by stitches which do not perforate the lumen of the bowel. (Hartmann.)

of the peritoneal cavity, which is already protected by suture, than for the protection of the abdominal wound from the contents of the intestine, which often possess a high degree of virulence. A patient may die as a result of infection extending between the layers of the abdominal wall, without the development of peritonitis. The reaction which

FIG. 202.

Suture of bowel to skin by stitches which perforate all of the coats of the bowel. (Hartmann.)

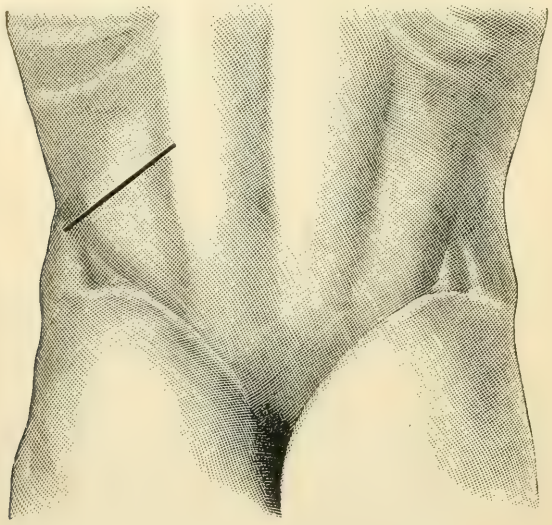
takes place in a wound within two days will sufficiently protect the surrounding tissues from infection.

In operating in two steps it is well to use interrupted serous sutures, and to leave the ends long, covering the bowel with a bit of iodoform gauze. If this is done, the surgeon will have no difficulty in ligating the bowel even though after this lapse of time it closely resembles the rest of the wound in appearance. The bowel may be

opened with a scalpel or a thermocautery. The incision should be considerably shorter than the wound in the peritoneum. If the operation is completed at once, the mucous membrane of the bowel is brought outward and stitched to the skin in order to protect still further the abdominal wound from infection. But as this protection is not absolute, it is well to leave two little gaps at the angles of the wound through which iodoform drains may be inserted.

During convalescence the fistula in the intestine may grow much smaller on account of cicatricial contraction. Such a fistula may be dilated by the introduction of increasingly larger rubber tubes; or, if this treatment fails, the incision may be prolonged from 0.5 to 1 cm. (0.2 to 0.4 inch) at either end in the direction of the lumen of the bowel. The partially cut mucous membrane is to be brought outward

FIG. 203.



Incision for lumbar colostomy. (Hartmann.)

and stitched to the skin. The care of a fecal fistula after the wound is completely healed is spoken of below. A lumbar colostomy is not so conveniently situated as an inguinal one. (Fig. 203.)

Establishment of an Artificial Anus.—If there is some complete obstruction below the fecal fistula, the latter acts necessarily as an artificial anus and discharges all of the intestinal contents; but if such a complete obstruction does not exist below, a portion of the fecal stream will pass by, and may produce pain, ulceration, obstruction, and dilatation below the fecal fistula. In general a fecal fistula tends to change into an artificial anus by the formation of a broad spur between the afferent and efferent portions of the intestine. If it is known at the time of operation that the whole fecal stream must permanently pass from the fistula, it is better to cut off the efferent bowel

so as to prevent any possibility of fecal matter passing through it. (Fig. 204.) This operation as performed by Maydl is carried out in two steps. The abdominal incision is made and the coil of intestine selected and brought out of the wound sufficiently far to permit the passage through its mesentery of a strip of iodoform gauze. The ends of the gauze rest upon the abdominal wall and keep the intestinal coil in position. (Fig. 205.) Both the afferent and efferent portions of the intestinal loop are stitched to the peritoneum. If the operation is to be completed at once, this suture should be carefully carried out; whereas if the bowel is not to be opened for one or more days, a few interrupted

FIG. 204.

Artificial anus. Immediate opening of bowel. (Hartmann.)

stitches are sufficient. The bowel is opened transversely through half of its circumference with a knife or Paquelin cautery. This opening suffices to permit the escape of intestinal contents, and a week later when granulations are well formed the rest of the intestine is divided and the iodoform gauze removed. As both ends of the intestine have a tendency to retract, they must be sutured to the skin with silver or aluminum bronze wire.

Schinzinger operates as follows: The intestinal coil is completely

divided at first, the efferent portion is sutured blindly and dropped back, and the afferent portion is stitched in the abdominal wound. This method is not to be followed unless the obstruction below will permit the passage of the secretion of the intestine itself. This operation eliminates entirely the lower portion of the bowel, the advantages and disadvantages of which are spoken of elsewhere.

Some surgeons attempt to make a special valve in the artificial anus. Giersuny recommends that the intestine be twisted for 180 or 270 degrees. Witzel draws the bowel through a slit in the gluteus maximus, or seeks to form an anus from the rectus muscle by splitting it into an anterior and a posterior half and bringing the intestine out between them. Gleich bores a hole through the iliac bone 3 or 4 cm. (1.2 to 1.6 inches) below its crest and brings the intestine out through it.

FIG. 205.

Establishment of an artificial anus.

These and similar attempts to make an artificial sphincter are almost invariably disappointing. An essential feature of the normal sphincter is its reflex action, and this, of course, must be wanting in any artificial anus. Furthermore, the annoyance to the patient of a simple artificial anus properly placed is not so very great. After a certain time the bowel evacuates its contents with considerable regularity, especially if the patient is careful what he eats; so that when no diarrhœa exists such a patient has one or two movements a day and nothing comes from the fistula between times. The need for an evacuation makes itself known much as it does when the feces pass from a normal rectum, provided, of course, that the fistula is situated in the large intestine. The nearer it lies to the rectum, the better as a rule is its action

When the wound is healed and the patient is out of bed, he wears an apparatus somewhat like a truss, which is only removed for defecation. The pad consists of an oval plate and a soft rubber ring filled with air or glycerin which surrounds the fistula. In this manner pressure is made upon the skin, and not upon the fistula itself. A small bit of gauze is worn between the pad and the opening in the bowel. If such an apparatus causes the patient discomfort, a special form of bandage may be constructed.

Closure of a Fecal Fistula.—This operation will be described without reference to the existence of any complicating disease, tumor, tuberculosis, etc. The anatomical and pathological peculiarities of such conditions are discussed in the sections on Diseases of the Intestine.

Small fistulas existing without a valve and which are not lined with a mucous membrane frequently close spontaneously. If they are lined with epithelium, they will often close after the epithelium has been destroyed by some caustic or the thermocautery. If the fistula is larger, say as large as a small lead pencil, and leads directly into the intestine, it may often be closed by a simple suture made around it just far enough away to include the whole scar. This cut extends into the bowel and after removal of the fistula the wound in the bowel is sutured with catgut. Parallel to the wound in the skin and 4 or 5 cm. (1.6 or 2 inches) away from it a crescentic incision is made, the skin and subcutaneous fat are lifted from the underlying fascia, and this bridge of skin is utilized to cover the previous

FIG. 206. FIG. 207.

Dieffenbach's method of closing a fecal fistula.

site of the fistula. The second wound is allowed to heal by granulations. (Figs. 206 and 207.)

If the simple operation just described fails to close the fistula, or if the size of the fistula is such that it is useless to try to close it by this method, the intestinal coil involved should be loosened from the abdominal wall, the fistula resected, and the wound in the intestine closed by direct suture. This operation was previously greatly feared on account of the risk of peritonitis. This risk is to-day a slight one provided the intestine is healthy and there is no complicating suppuration in the neighborhood. In order to secure a certain result it is necessary to separate the intestine from the anterior abdominal wall to such an extent that normal portions of intestine can be sutured without tension. Furthermore, it is essential to obtain primary union of the intestine if one would avoid risk and have a perfect result. The incision is made through the skin from 3 to 5 mm. (0.1 to 0.2 inch)

away from the border of the fistula, and when the superficial tissues have been divided the incision is continued until the peritoneal cavity is opened. The operator may find it of advantage to pass into the lumen of the bowel a finger protected by a rubber cot or a glove in order not to wound it. As soon as the peritoneal cavity has been opened the forefinger is passed into it and the dissection continued until the intestine containing the fistula is entirely free. In the neighborhood of such a fistula there will always be found adhesions between different portions of intestine or omentum or parietal peritoneum. These should be divided in as far as they interfere with the proper suture of the intestine, otherwise they should be left alone, since they afford some protection to the rest of the peritoneal cavity and fix the sutured intestinal coil in the neighborhood of the abdominal wound. Hasty separation of adhesions may easily lead to accidental tearing or cutting of some portion of the intestine.

This separation of the affected intestine is the most difficult part of the operation. When it is completed, the edges of the fistula in the intestine are freshened and cut away until the thread can be passed through the normal intestinal wall. In doubtful cases it is better to remove too much than too little. The edges of this intestinal wound are to be united transversely by two rows of sutures, and the wound in the abdominal wall should be partially closed with doubly placed silver or bronze wire stitches. A gap should be left through which a short strip of iodoform gauze may extend to the sutured portion of intestine. This serves as a safety-valve in case the suture in the intestine does not hold, and protects the general peritoneal cavity from infection. In four or five days the iodoform gauze can be changed for a small, short drainage-tube which should be left in place for a few days longer.

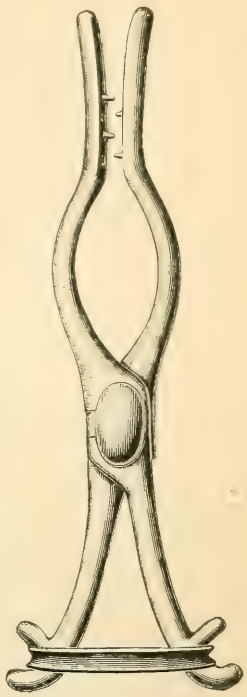
The length of the intestinal sutures in this operation depends upon the size of the defect in the intestine. If a great deal of tissue has to be cut away, the intestinal suture is similar to the suture after a circular resection of the intestine.

An artificial anus may be closed in a number of ways. Dupuytren's method, which was the only one practised in pre-antiseptic times, rests on the principle of changing an artificial anus into a fecal fistula and then closing this in the manner above described. The first step in this method is to overcome the spur—that is, the partition between the afferent and efferent portions of the bowel. Dupuytren used an instrument like a pair of shears whose blunt blades are provided with shallow ridges each fitted into one another. One of these blades was introduced into each portion of the bowel and the intervening spur was compressed by means of a screw in the handle. This screw was tightened a little each day until the spur was cut through in about a week. As the spur was thus gradually destroyed by pressure the opposing serous surfaces united by traumatic adhesion in case they had not previously done so. In this manner opening the peritoneal cavity was avoided and the patient was protected from peri-

tonitis. Numerous defects showed themselves in the use of this instrument, which has been variously modified, but is rarely used at the present time.

Mikulicz has also devised an instrument to crush a spur, which is shown in Fig. 208, which he calls the kentrotribe. Pressure is obtained by means of an elastic band placed around the handle. This gives a more gradual pressure than a screw is capable of doing.

FIG. 208.



Mikulicz's kentrotribe.

Krause has a clamp which makes a pressure in the deepest part of the spur so as to produce anastomosis between the afferent and efferent loop. When such an opening is well established, he sutures blindly the external openings of the intestine.

One should judge by digital examination when the spur is sufficiently divided. When such is the case, at least a part of the feces will pass by the natural channel. The artificial anus may then be closed by one of the methods described above. The best plan on account of the size of the fistula is to free the intestine from the abdominal wall, freshen the edges of the fistula, and close the wound by direct suture.

The portion of the intestine containing the artificial anus may be resected and its contents united by a circular suture. This operation, which was first performed by Billroth, requires a wide opening of the peritoneal cavity and a free separation of the affected portion of the intestine. It should be carried out according to the principles of a careful laparotomy. The abdominal incision and separation of the intestine are made according to the rules given for direct suture to close an intestinal fistula. There is nothing peculiar about the circular suture except that the stitches should everywhere pass through healthy intestine. As long as the peritoneal cavity is to be freely open, it makes no special difference whether a few centimetres of intestine more or less are resected, and the success of the operation depends upon the ability of the operator to oppose practically normal serous surfaces by his suture. The opening in the abdominal wall made by cutting around the fistula will not be sufficient for the operation. It will be either necessary to extend the wound in one or both directions, or else to make a second wound near the fistula through which one can open the peritoneal cavity and loosen the affected intestine without risk of soiling the peritoneum. The greatest advantage of resection with circular suture is the promptness with which the patient is cured of his trouble.

A further advantage is the freedom from subsequent stenosis, kinking, etc. The risk of the operation is the only disadvantage. It may be followed by post-operative peritonitis due to infection at the time of operation, or to subsequent infection from an imperfect suture. With the present methods of operating the risk of infection at the time of operation is slight provided there is no suppuration in connection with a fistula. Temporary tamponade protects the general peritoneal cavity during the manipulation of the intestine. The proper closure of a wound can be secured by the introduction of a small iodoform gauze tampon. Secondary infection of the peritoneum from an

FIG. 209.

Resection of intestine with lateral anastomosis. Posterior suture inserted. The free ends of the bowel inverted and sutured. (Richardson.)

imperfect suture is somewhat difficult to avoid as the sutured intestine lies free in the abdominal cavity, and infection due to a leaky suture will easily produce a general peritonitis, whereas in case of the operations performed in two or more steps the general peritoneal cavity is more or less protected by adhesions. As previously emphasized, there is a great difference between suture of the small and suture of the large intestine. For the reasons mentioned suture of the small intestine is more certain, while risk of infection during operation upon the small intestine is much less because its bacteria are fewer in number and possess less virulence.

The operator will be guided by circumstances in his choice of methods. Indeed, the different methods may frequently be combined with advantage. Thus in place of a circular resection with suture one may perform lateral anastomosis and close both intestinal ends blindly. (Figs. 209 and 210.) If the small intestine has to be united with large intestine or if the lumina of the two portions of the intestine vary greatly, a lateral implantation is preferable. If the artificial anus is in the small intestine, the best operation is usually resection with circular

FIG. 210.

Lateral anastomosis completed by Lembert continuous suture. (Richardson.)

suture, or lateral apposition, or implantation, the operation being performed after free opening of the peritoneal cavity. If the opening is in the large intestine, Mikulicz prefers to divide the spur with a kentrotribe and subsequently to close the fistula.

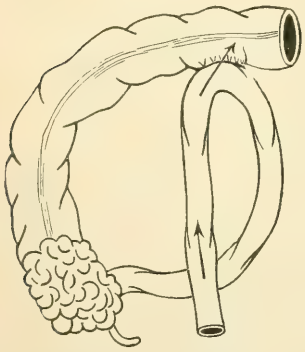
Entero-anastomosis.—A simple entero-anastomosis is the establishment of communication between two portions of the intestine. The simplest form of all is a lateral anastomosis. The object of entero-anastomosis is to enable the fecal stream to pass around some obstruction. The portion of the intestine which is thus eliminated must not be too great, since although it remains within the body its digestive power is not utilized.

Entero-anastomosis is often associated with another operation, such as gastro-enterostomy, or a resection of intestine.

The technic of lateral entero-anastomosis by means of suture is similar to that of gastro-enterostomy. Figs. 209 and 210 show the technic as applied to the intestine. The anastomosis may be brought about by suture or by the use of a Murphy button.

Both methods are suitable for anastomosis in the small intestine. The choice of method should be made in accordance with the principles applicable to gastro-enterostomy. If the small intestine is to be anastomosed with the large, so that fluid or grumous contents will pass through the opening, Murphy's button is also practical. It is unsuited and even dangerous for an anastomosis between two portions of large intestine.

FIG. 211.



Entero-anastomosis with isoperistaltic arrangement of intestine. (Wölfler.)

FIG. 212.

Entero-anastomosis with antiperistaltic arrangement of intestine. (Wölfler.)

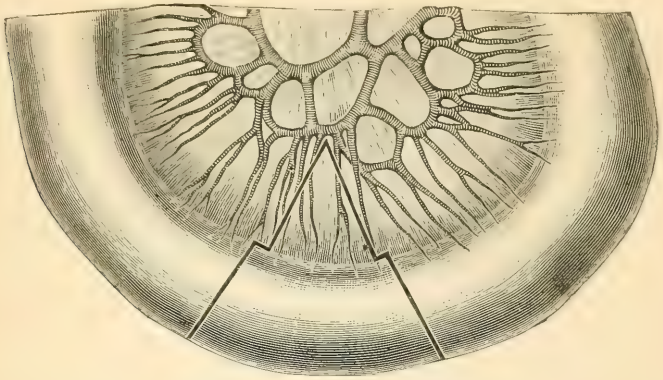
The arrangement of the two portions of intestine can be isoperistaltic or antiperistaltic. (Figs. 211 and 212.) In the first case the fecal matter flows more easily into the efferent loop, and this arrangement is therefore preferable. However, the other arrangement also gives satisfaction. The points in the intestine chosen for anastomosis are usually opposite to the attachment of the mesentery. In the large intestine the opening should be made through a muscular band.

Resection of the Intestine.—The term resection as applied to the intestine indicates the removal of a complete circle of the gut, while the removal of less than a complete circle is termed excision. The portion resected may be of any length. Experiments upon animals and observations upon man show that life is possible after removal of about half of the small intestine. The lower portion of the intestine can be spared better than the upper, and the large intestine best of all.

Successful instances of intestinal resection are mentioned by Ruggi (330 cm., 13.2 ft.), Montprofit, Fantino (310 cm., 12.4 ft.), Shepherd (234 cm., 9.3 ft.), Dreesmann (215 cm., 8.6 ft.), Kocher (208 cm.,

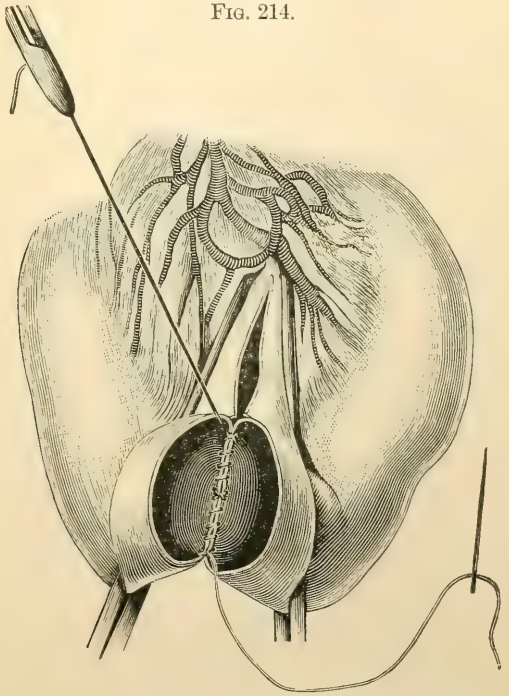
8.3 ft.), Köberle (205 cm., 8.2 ft.), Lexer (200 cm., 8 ft.). In most of these cases no mention is made of the subsequent condition of the

FIG. 213.



Resection of intestine, with circular enterorrhaphy. Incision made so as to avoid the vessels of the mesentery. (Hartmann.)

FIG. 214.

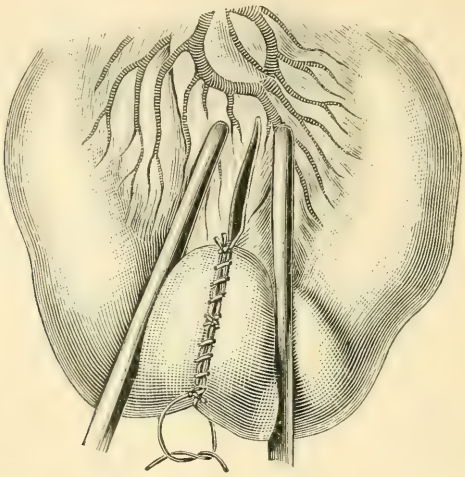


Circular enterorrhaphy. The beginning of the first suture. The elastic clamps prevent soiling of the wound by blood or feces. (Hartmann.)

patient. Mikulicz resected 215 cm. (8.6 ft.) of gangrenous intestine from a hernial sac in a man aged thirty. This patient was entirely well three years afterward and his nutrition was not apparently affected in any way.

Circular Resection, or End-to-end Anastomosis.—This is the simplest form of resection. The bowel is united by suture (Figs. 213–216), or, in case of the small intestine, by means of a Murphy button.

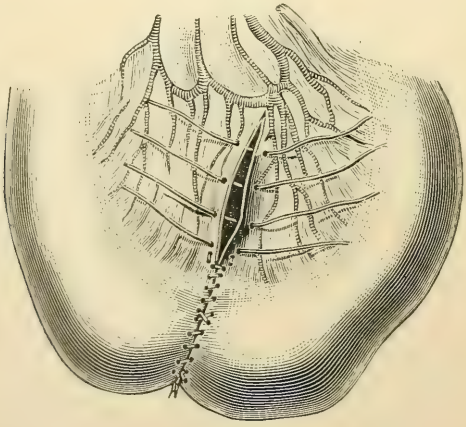
FIG. 215.



Circular enterorrhaphy. End of the first suture. (Hartmann.)

The lumen of normal small intestine is everywhere the same, and circular suture presents no difficulties. If small intestine is to be united to large intestine, or if the lumen of the small intestine is greatly

FIG. 216.

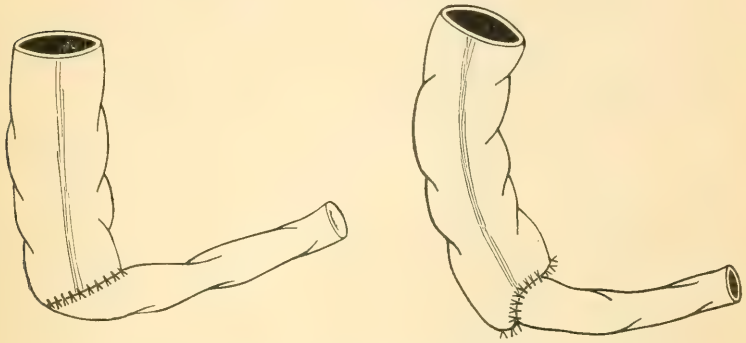


Circular enterorrhaphy. Clamps removed. Suture of mesentery. Second intestinal suture which does not perforate the lumen of the bowel. (Hartmann.)

dilated by chronic obstruction, the difference in size has to be met by special technic. The simplest plan is perhaps to cut the smaller bowel obliquely so that the cut edges of the two portions to be sutured

will have approximately the same length. (Fig. 217.) In the course of time the difference in lumen will disappear. Another method is to suture a part of the cut end of the intestine having the greater lumen, so as to reduce its end to the size of the other. (Fig. 218.) This method is faulty in that a weak point always exists where the transverse suture meets the circular suture. If the fecal stream passes from the intestine having the greater lumen to that having the smaller lumen, the strain upon the transverse suture is very great.

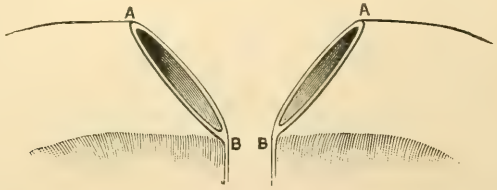
FIG. 217. FIG. 218.



Circular anastomosis of portions of the bowel having different lumina.

In using the Murphy button slight differences in the diameter of the intestine are easily overcome. If the differences are great, a lateral anastomosis is to be preferred.

FIG. 219.



Resection of intestine. Incision oblique to increase the lumen of the bowel: A, free side of intestine; B, mesenteric attachment. (Hartmann.)

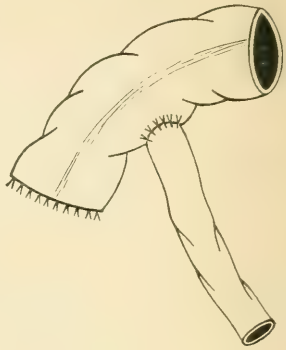
Even if both ends of the intestine have the same diameter, it is better to cut them a little obliquely. (Figs. 219 and 220.) The side of the intestine toward the mesentery is always more vascular, and as the vessels radiate from the mesentery around the intestinal wall and form few anastomoses one with the other, an oblique incision which removes less of the mesentery than it does of the opposite wall best provides for the nourishment of the cut edge of the bowel. An oblique incision in the opposite direction is always to be avoided. Furthermore, every circular suture of the intestine reduces the lumen by folding in a portion of the intestinal wall. In the course of time this

ridge disappears, but in the first few days after operation it may produce a relative stenosis. If both intestinal ends are cut obliquely, the lumen at the suture will be slightly increased thereby and immediate or later stenosis prevented.

FIG. 220.

Resection of intestine. Circular suture. (Hartmann.)

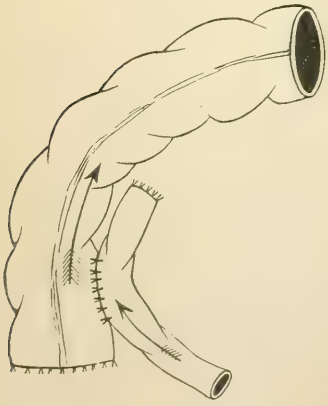
FIG. 221.



Lateral implantation.

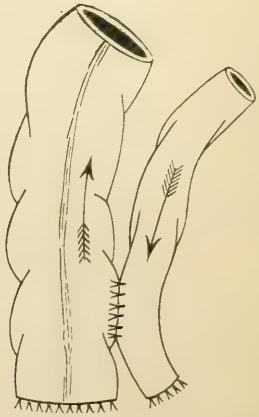
Lateral Implantation, or End-to-side Anastomosis.—This method of anastomosis is an imitation of the natural connection between the small intestine and the large intestine. It is rarely employed except in cases in which there is considerable difference in the lumina of the two portions of the intestine. This anastomosis may be carried out with a suture or with a button. The open ends of the intestine are closed blindly by suture. (Fig. 221.)

FIG. 222.



Isoperistaltic lateral apposition.

FIG. 223.



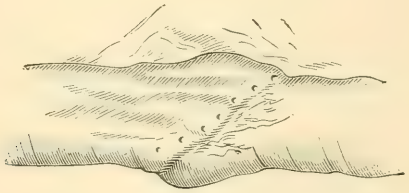
Antiperistaltic lateral apposition.

Lateral Apposition, or Side-to-side Anastomosis.—This form of anastomosis is carried out according to the simple principles given on page

398. It is equally efficient whether the two portions of intestine have the same or different lumina.

The apposition may be isoperistaltic or antiperistaltic. (Figs. 222 and 223.) The objection to the latter method is that it leads to an accumulation of feces in the blind end of the lower bowel. Therefore when conditions permit the surgeon to choose freely, he will decide on isoperistaltic anastomosis. In many cases it is impossible to arrange the portions of intestine in this manner without prolonging the operation unduly. Under such circumstances an antiperistaltic union should be effected, the practical results of which method are sufficiently good. Frey's experiments upon animals show that an isoperistaltic lateral anastomosis smoothes itself out in the course of a few months so that it appears almost like an oblique circular anastomosis. (Fig. 224.)

FIG. 224.



Isoperistaltic lateral apposition after a period of six months. (Frey.)

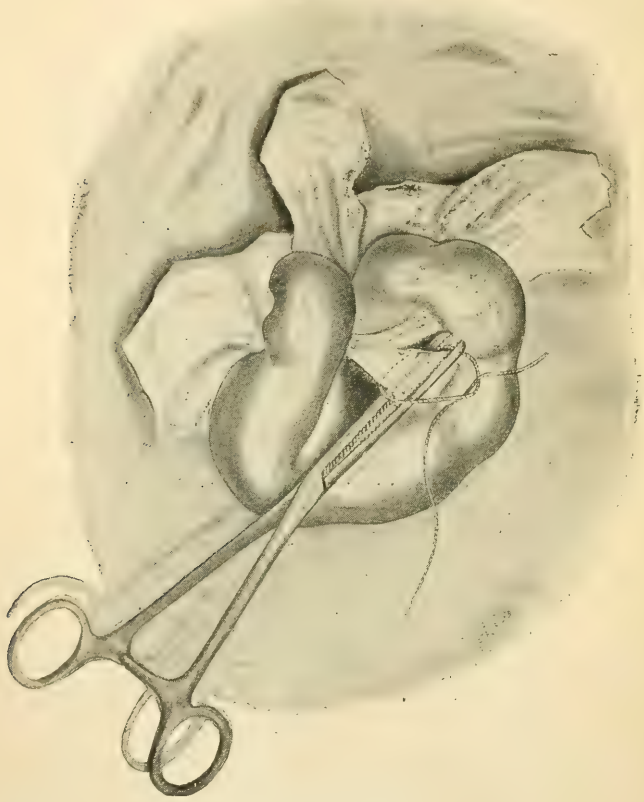
Intestinal Resection with Circular Anastomosis.—The site of the skin-incision is determined by the portion of intestine to be resected. If there is no counterindication, the incision for resection of small intestine or transverse colon is made in the centre of the median line. The length of the cut varies from 12 to 20 cm. (4.8 to 8 inches). After the peritoneal cavity is opened, the portion of intestine resected is brought as far out of the peritoneal cavity as possible and separated from it by a careful tamponade. (Fig. 59.)

The mesentery is next separated from the portion of bowel to be resected. First a small opening is made in the mesentery near its attachment to the bowel, and then a second one 2 or 3 cm. (0.8 to 1.2 inches) from the first. The portion of mesentery between these two openings is clamped and a slender thread is passed, as shown in Fig. 225. This ligature crosses the jaws of the clamp and is gradually drawn taut as the clamp is withdrawn; thus it comes to lie in the groove made by the pressure of the clamp. Another clamp is applied between the ligature and the bowel, and the mesentery cut between them. In this manner the mesentery is tied and divided step by step. If the mesentery contains little or no fat, it is unnecessary to press into it with clamps before drawing the ligature taut.

Some surgeons prefer to cut the intestine away from the mesentery with a scalpel or a pair of scissors, sewing each bleeding vessel as it is divided. This method takes longer and causes a greater loss of blood. Another method is to cut out a wedge-shaped piece of mesentery with

the intestine. This plan is inadvisable because the collateral circulation is unnecessarily sacrificed. It has to be adopted, however, in case of a carcinoma of the intestine with secondary infection of lymph-glands situated in the mesentery.

Fig. 225.



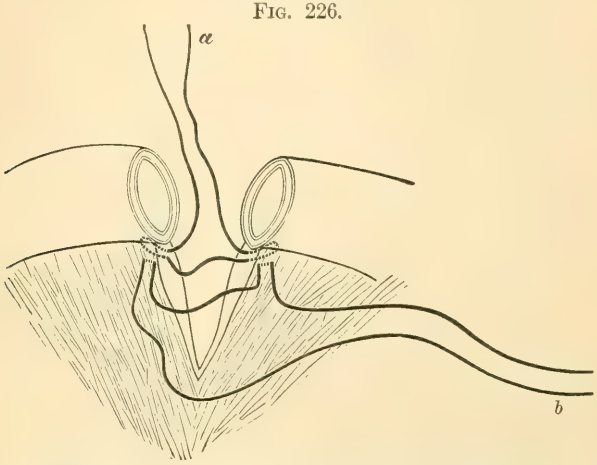
Ligation of the mesentery.

The portion of intestine is stripped of its contents and is shut off from the rest of the bowel by intestinal clamps (Fig. 215) or a temporary ligature, or by the fingers of the assistant. Two or 3 cm. (0.8 to 1.2 inches) within the point selected for the incision the affected loop of bowel is firmly clamped or ligated. It is then cut through with straight scissors, not transversely, but at a slight angle, so that a little more of the free border of the intestine is removed than of the portion which is attached to the mesentery. (Fig. 219.) The division of intestine must exactly coincide with its separation from the mesentery. If any bowel projects beyond the mesentery which remains, its nutrition is endangered.

The ends of the bowel are united by a suture or Murphy button. The small intestine is completely surrounded by serosa with the exception

of a portion 2 or 3 mm. (0.1 or 0.2 inch) in width where it is attached to the mesentery. As the success of the suture depends chiefly upon the exact approximation of serous surfaces, the point in the suture-line where the mesentery is attached to the bowel is a weak one and requires especial attention. Mikulicz first inserts an intramesenteric suture (Fig. 226, *a*), which approximates the tissues of the mesentery between its two serous layers and also the muscular coats of the intestine. He next inserts two perimesenteric sutures, which approximate the serous surfaces of the mesentery in accordance with Lembert's principle. One

FIG. 226.



Suture of the mesentery in circular resection of the intestine as practised by Mikulicz: *a*, intramesenteric suture; *b*, paramesenteric suture.

of these stitches is placed on either side of the mesentery. For the sake of clearness only one appears in the illustration. (Fig. 226, *b*.) The ends of the intramesenteric suture are cut short while the ends of the perimesenteric sutures are left long. He next inserts a continuous suture from within the intestine passing through all of its coats. (Fig. 107.) This suture begins at the mesenteric attachment and extends through nearly half the circumference of the bowel. It is then recommenced at the mesenteric attachment and extends as far in the other direction as possible. The gap which of necessity remains is closed by two or three interrupted sutures tied externally. The usual continuous serous suture completes the operation. The ends of this suture are fastened to the perimesenteric suture on either side. When the suture is finished, the parts are cleansed with a weak antiseptic solution and the suture-line is dusted with iodoform. The gap in the mesentery is closed by a continuous suture in order to prevent incarceration of intestine within it. The needle should not be inserted deeply lest some mesenteric vessel be included in the suture.

Lateral Implantation and Lateral Apposition.—The blind end of intestine is closed by a purse-string suture. The enterotribe is pressed across the bowel about 1 cm. (0.4 inch) from the point to which the

mesentery has been separated from it so as to facilitate inversion of the same. The portions of intestine are sutured in much the same manner as in circular resection, with the exception of the intramesenteric suture. The technic of lateral apposition is the same as that of entero-anastomosis. The operation is usually simpler if the portion to be resected is first removed and the blind end of the bowel is closed before the anastomosis is made. The length of the blind sac should not be too great lest feces accumulate in it. But it must not be so short as to threaten the integrity of the anastomosis. If only a narrow portion of intestine is left between the two sutures, it may easily necrose. If a Murphy button is employed, the technic is similar to that given on page 405. Closure of the abdominal cavity following intestinal resection is discussed on page 480.

Intestinal Resection performed in Steps.—In the methods of intestinal resection hitherto described the free ends of intestine are immediately brought together by suture or the Murphy button. Such a method is by far the best in the case of the small intestine, which is completely surrounded with peritoneum. Technically the same methods of operating are applicable to the large intestine, especially to the transverse and the sigmoid colon. In the rest of the large intestine resection with immediate suture is possible by a method of lateral implantation or lateral apposition. Circular suture is not practical on account of the absence of the peritoneum over a considerable circumference of the bowel. While the completion of an operation is therefore possible at one time, it is not advisable, and in certain cases is distinctly dangerous. There are several reasons for this. The wall of the large intestine varies in thickness in different places and the appendices epiploicæ add to the difficulties of suture. The wall of the large intestine is not so well supplied with vessels as that of the small intestine, and the reactive changes which are necessary for the perfect sealing of the suture-line are not so satisfactory as in the case of the small intestine. The thick character and slow movement of the contained feces, and the greater virulence of the bacteria within the large intestine, are additional reasons why immediate suture of this portion of the intestine entails a greater risk. The use of the Murphy button, which in the case of the small intestine frequently leads the operator out of difficulty, is in the case of the large intestine absolutely counterindicated. In view of these facts Mikulicz does not employ immediate resection and suture of the large intestine except in unusual circumstances.

When the small intestine is to be united to the large intestine—for example, in resection of the cæcum—the operator will have to choose between the various methods. If the local and general conditions are satisfactory, the operation may well be completed at once. If any doubt exists, it is safer to operate in the manner described below.

Resection of the large intestine is performed as follows:

1. The portion of intestine to be resected, together with the tumor or other diseased tissues—for example, the lymph-glands—is separated from the mesentery to a distance of 3 or 5 cm. (1.2 to 2 inches) from

the tumor and brought out through the abdominal incision. The gap or rent in the mesentery is closed by suture and the two portions of bowel which form the spur are brought together by a continuous serous suture.

2. The peritoneal cavity is then closed by suture and the skin is sutured to the projecting intestine. The affected bowel may then be cut away either immediately or after twelve or twenty-four hours. At a later period the spur between the afferent and efferent portions of bowel is destroyed, and still later the artificial anus is closed.

The advantages of this plan of procedure are:

1. Infection of the peritoneal cavity due to opening the lumen of the intestine is absolutely avoided, since the peritoneal cavity is closed by suture and adheres before the intestine is cut into.

2. The stenosis of the intestine which is so frequently the chief indication for resection has often produced ulcers in the portion of intestine to be resected. Therefore unless a considerable portion of bowel is removed the suture will be made through badly nourished tissue. The success of an immediate operation may also be defeated by sluggish circulation due to the paralytic condition of the bowel. If suture is postponed to a time in which the intestine is completely empty and its tone is restored, the suture is much more likely to succeed.

3. The nutritive condition of a patient who has for some time been suffering from stenosis of the intestine is usually bad, and he is therefore not in a condition to outlive even a mild infection. The contents of the intestine are besides made more than usually virulent by such stagnation. Most of the patients are of advanced age.

4. By means of an operation in several steps portions of intestine can be united whose immediate union by suture would be impossible or dangerous on account of too great tension. This disadvantage can be avoided in an immediate operation by establishing an anastomosis between distant portions of the intestine in place of suturing the cut ends of the bowel. For example, the transverse colon or cæcum or small intestine may be united with the sigmoid flexure, but such an operation is a much more serious procedure than simple resection in several steps.

5. The operative shock of resection in steps is less and the time required for operation is less than for an immediate resection and suture.

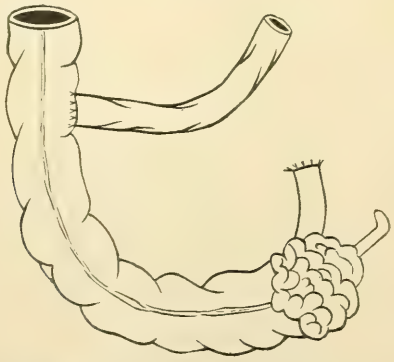
The chief objections which have been made to intestinal resection in steps are that the period of convalescence is prolonged, and that the patient has to pass through an unpleasant stage of artificial anus. These objections are scarcely sufficient to counterbalance the advantages given above. Therefore the operation in several steps must be considered the normal procedure for extirpation of tumors of the large intestine and for the cure of extensive ulcers. It is also a satisfactory method to pursue when volvulus or invagination makes resection necessary. In case of carcinoma complicated by ileus this method of

operation is too severe for the patient to endure. It is better to establish a simple artificial anus, and to leave the resection to a subsequent period when the local and general condition may be more favorable.

Intestinal resection in several steps is not a new operation. For many years it has been practised by surgeons in cases of necessity. In 1892 it was first performed by Block as an operation of choice. He recommended it, however, only in cases in which the mesocolon was sufficiently long to permit the tumor to be brought out of the abdominal wound without dividing the mesocolon. There are comparatively few such cases.

Operation in steps may be carried out in a different way. An artificial anus may be established above the affected portion of intestine, and at a later date the intestinal resection and suture may be performed as a single operation. This plan of procedure has little to recommend it since the second operation carries with it the chief dangers of suture of the large intestine. Mikulicz adopts the plan of a preliminary artificial anus in case of acute ileus, but the subsequent resection of the affected portions of intestine is even then made in steps, as above described.

FIG. 227.



Partial elimination of the intestine, with suture of the upper end of the eliminated portion. (Wölfler.)

There is still another method of operating in steps. An enteroanastomosis may be established above and below the portion of intestine which is to be resected; at a later date the resection is performed and the cut ends of the bowel are closed blindly. This method has the great advantage that the patient is not subjected to the annoyance of a temporary artificial anus, but it is not wholly free from the risks of a complete operation carried out at one time.

Elimination of the Intestine.—By elimination of a portion of intestine is meant its separation from the rest of the alimentary canal so that it takes no part in digestion although it remains in the abdominal cavity. If it is the seat of malignant growth, the latter may be removed at a later date; if the trouble is benign, this is unnecessary.

A simple anastomosis usually eliminates a portion of the intestine, which is thereby cut off from the fecal stream even though there is no mechanical obstruction. This is especially true of a gastro-enterostomy, but for the sake of clearness the portion of the bowel cut off by a simple anastomosis will not be described as eliminated.

Elimination may be partial or complete. In the former case only one end of the portion of intestine in question is cut loose from the alimentary canal (Fig. 227), whereas in total elimination both ends are cut off from the alimentary canal.

The various forms of partial and complete elimination are as follows:

1. Partial elimination of intestine with—

a. Suture of the upper end, or

b. Suture of the lower end; and

2. Total elimination of intestine with—

a. Suture of both ends either together so as to form a ring, or separately;

b. With suture of one end, the other one forming a fistula;

c. Each end forming a fistula;

d. With closure of both ends when a fistula already exists.

Partial Elimination of Intestine.—Although simple anastomosis relieves a portion of intestine of most of the fecal stream, yet because some of the intestinal contents find their way into this portion it may be desirable to eliminate it. Furthermore, in gastro-enterostomy the flow of bile through the pylorus into the stomach may make it desirable to effect a mechanical obstacle by a suture at the pylorus or upper part of the duodenum. Thus Billroth's second method of pyloric resection and the various modifications are forms of partial elimination. Closure of the lower end of the eliminated bowel while the upper remains open is usually unnecessary and may be dangerous. In such a cul-de-sac feces or intestinal secretion may collect to an unpleasant extent.

The operation for partial elimination is as follows: Anastomosis is performed as usual and the upper or lower end of the affected intestine is cut transversely and closed blindly by suture. This step in the operation may precede the anastomosis. A variation of this procedure is the lateral implantation of the intestine above the obstruction into the intestine below the obstruction and blind suture of the upper end of the eliminated portion. (Fig. 227.)

Total Elimination of Intestine.—The method previously followed of closing both ends of the eliminated bowel blindly or of suturing one to the other so as to form a ring has proved somewhat dangerous. Normal intestine thus treated will give no trouble, but diseased intestine continues to secrete fluid, especially if it contains ulcers, while its power of resorption is diminished. Under such circumstances distention may increase until the bowel bursts. In a normal bowel secretion and resorption are about equal and the mucous membrane gradually atrophies. A safe plan to follow under such circumstances is to

open the eliminated portion to the outer world by stitching one or both cut ends into the abdominal wound. The technic of this operation is similar to that of resection. The extirpation of the eliminated portion of bowel at a later date is usually much simpler than resection carried to completion at one time.

An eliminated portion of intestine may be utilized for plastic operation; for example, as a substitute for the bladder.

CLOSURE OF THE ABDOMINAL WOUND AFTER OPERATION UPON THE STOMACH AND INTESTINE.

The abdominal wound is usually closed after operations upon the stomach or intestine, but it may be tamponed or drained. The escape of bacteria when the stomach or intestine is opened can rarely be prevented. Furthermore, any suture-line may prove insufficient. Under these circumstances it may be thought better to drain the suspected region, but serious consequences may follow this practice. A tampon changes the normal condition of the organs with which it comes in contact. If a suture is perfect, it make no difference whether the neighboring parts are deprived by a tampon of visceral and parietal peritoneum. But if there is a weak spot in the suture, the opposing serous surfaces in the immediate neighborhood may form adhesions about the area of infection, which will not only prevent its spread, but will also materially strengthen the suture-line. A tampon may also do injury by setting up adhesions between the suture and other portions of intestine and materially interfering with peristaltic action. The result is stagnation and increase of pressure within the intestinal lumen with the possibility of perforation. If this perforation takes place into the tampon after the surrounding adhesions have become firm, the damage is not great. A larger or smaller intestinal fistula is the result, which will usually close sooner or later spontaneously. If the perforation takes place in the first days after operation, the escaping fecal matter may spread infection in the immediate vicinity of the tampon. Recovery will certainly be delayed, and in many cases infectious material will gradually spread through the abdomen setting up a diffuse peritonitis. For these reasons the use of a tampon for resection of the stomach or intestine and for all sorts of intestinal suture is inadvisable. Experience has shown that the peritoneum can take care of the limited amount of infectious material which reaches it during a properly performed resection of the stomach or small intestine. Drainage should therefore be omitted in uncomplicated cases of this character. If for some reason or other the risk of infection is greater than usual—for example, if gangrenous intestine is resected in the case of strangulated hernia, and the nutritive condition of the sutured bowel is in doubt; or if a great quantity of infectious material escapes into the peritoneal cavity during an operation, or if the peritoneum was infected before operation—for example, in appendicitis—drainage is indicated, but the iodoform gauze should not be wrapped

around the sutured intestine. A single strip of gauze extending to the suture-line will serve as a safety-valve, and will serve to conduct outward a great quantity of secretion.

TREATMENT AFTER OPERATION UPON THE STOMACH OR INTESTINE.

The treatment of patients upon whom laparotomy has been performed has been given on page 223. If the alimentary canal is the seat of operation, special attention must be paid to the diet. The higher up the alimentary canal has been opened, the greater the necessity for such attention. Experiments by Chlumsky show that the strength of an intestinal suture diminishes up to the fourth or fifth day, and then gradually increases until by the eighth day it is usually perfectly strong. It should be remembered, however, that every suture-line forms a sort of stenosis which disappears only with the lapse of time, and that perforation may take place many days after operation.

The rules for diet are the same whether anastomosis is made by suture or by a Murphy button, except that the diet should be carefully regulated until the button is out of the intestine.

A patient who has undergone a major operation upon the stomach should receive nothing by mouth for one or more days. Even when this rule is observed, the stomach is not empty, but contains its own secretion, which is often considerable, more or less blood, and frequently regurgitated bile and pancreatic juice. If there are symptoms of retention of gastric contents, they should be drawn off through a stomach-tube. This procedure is much less dangerous than the distention of a sutured stomach or severe vomiting. General rules for diet are unnecessary since the rules for each patient must be made according to circumstances. The first fluid given should be of such a character that it cannot coagulate, such as water, bits of ice, wine and water, tea, weak lemonade, etc. Later the patient receives broth, milk, chocolate, coffee, egg, gruel, etc. Solid food is given in eight or ten days, the first articles being toast, mush, soft eggs, light meat, rolls, etc. If all goes well, the patient receives ordinary diet in about four weeks.

If after one or two days the patient is unable to take and retain as much as 1000 c.c. (2 pints) of fluid nourishment in twenty-four hours, he must be given nutrient enemata. This is the routine practice during the first days after the more severe operations upon the stomach. From 150 to 250 c.c. (5 to 8 ounces) are injected at a time, and the daily quantity should be about 1000 c.c. (2 pints). Wine and water (1 to 4) with a little salt and 10 per cent. of glucose make a good enema. Oatmeal gruel and peptonized milk and the various predigested liquid foods are also employed. If the patient has difficulty in retaining nutrient enemata, the quantity in an enema should be reduced. It should be made of the consistence of gruel and should contain a little opium. A patient thus treated should receive a hot

rectal irrigation every second or third morning. The quantity and specific gravity of the twenty-four hour urine are a good indication of the resorptive function of the rectum. Some surgeons prefer to give artificial foods, but Mikulicz has never found it necessary to resort to them for administration either by the mouth or through the rectum.

The diet after gastrostomy and jejunostomy has been spoken of on pages 423 and 456. After operation upon the lower bowel the patient should receive for about a week a fluid diet to which there will be very little residue. After suture of the large intestine Mikulicz recommends a cleansing enema given by the surgeon himself eight days after operation. Laxatives are given after intestinal suture only in case symptoms of intestinal paralysis appear.

When a fecal fistula is established, the patient receives his regular diet two or three days after operation; and if the bowels do not move spontaneously within a reasonable time, he is given laxatives.

HERNIA.

By Prof. Dr. E. GRASER.

CHAPTER XX.

HERNIA WITHOUT COMPLICATIONS.

SOURCE OF HERNIA AND ITS SIGNIFICANCE.

About one of every twenty to thirty individuals has a rupture of some sort. The proportion in males is as 1 is to 14.9 and in females as 1 is to 44.7. A large percentage of the cases that are seen for the first time are in children under one year of age; for instance, one-seventh of all cases of inguinal hernia. The minimum number of cases is observed about the fifteenth year of life. From this time on, the number increases, and reaches a maximum in males at about sixty-five years and in females at seventy years of age. Berger found that of 7542 cases examined with reference to heredity, 2079 were positive in this respect, the proportion being about as 1 is to 3.6. Hernia on the right side is much more common than on the left side, especially in males, the difference being most marked in the early years of life.

Several hernias may be present in one individual at the same time. Of 6220 cases of inguinal hernia examined by Berger, 1042 were simple and 4526 were bilateral. Of 829 femoral hernias in women, 506 were simple and 323 combined with other hernias; 213 were crural. There were numerous combinations of inguinal and femoral hernia on the same side (222) and on the opposite side (111).

As far as the hernia is concerned, it may be congenital, especially in the umbilical region, because of defective development. The viscera, however, do not protrude from within outward, but normal retraction has not taken place so that a certain portion of the viscera is left outside. Congenital hernia occurs also in the inguinal region because of insufficient obliteration of the vaginal process. If an oblique inguinal hernia is present at birth, there are usually other peculiarities, such as adhesions between the testicle and the intestine, which developed before the organ descended. In most of the so-called congenital inguinal hernias only the sac itself is congenital. Certain authors claim that the vaginal process is of importance in all cases of inguinal hernia, whereas others claim that it is of no importance whatever and bears no relation to inguinal hernia developing later in life. Without doubt both are in error. The degree of obliteration may vary considerably, but it is uncommon to have a free communication between the vaginal

process in the peritoneal cavity later in life. It is more apt to close at the scrotal end, and may remain patent in the region of the cord even as far as the internal abdominal ring. Knowledge on this subject is insufficient. Francke found a congenital hernial sac 18 times—*i. e.*, in 28.6 per cent.—of 63 cases operated for oblique inguinal hernia; Beresowky found a congenital sac 42 times—*i. e.*, in 35 per cent.—in 124 cases operated upon in Kocher's clinic; and Wood found a patent vaginal process in 127—*i. e.*, in 33.3 per cent.—of 370 cases of inguinal hernia. These figures express in a measure the importance of this vaginal process. The number of cases in which the vaginal process is closed below but patent above, forming a small funnel in the region of the internal abdominal ring, is probably equally large. This, of course, would be a convenient starting-point for an inguinal hernia. In females the diverticulum of Nuck is also of importance in the etiology of inguinal hernia.

Even if the vaginal process is not taken into consideration, certain regions of the body are predisposed to hernia, especially the regions where the abdominal structures are less resistant. These weak places are present in every individual, but are much more pronounced in some than in others. The inguinal canal is one of the weakest spots in the abdominal wall in any individual. The wider it is and the straighter its course the more readily will a hernia develop in this region. A large external abdominal ring in itself is of no special importance in the etiology of hernia. However, it frequently happens that when the external ring is large the canal itself is apt to be quite wide, although the variations in this direction are great. A wide inguinal canal is frequently associated with a lax anterior abdominal wall with considerable separation of the pillars of the external ring and with lax intercolumnar fibres. The external ring, instead of being a slit in the fascia bounded by two firm pillars, may be a round opening. The inguinal canal is abnormally wide in cases in which the cord is surrounded by a considerable amount of fat. This fat frequently forms finger-like rolls which diminish the resistance in this region. Bayer considers that complete absence of fat in the inguinal canal is characteristic of congenital hernia. In certain cases the inguinal regions appear soft, so that there is a slight bulging parallel to Poupart's ligament even when the abdominal parietes are at rest. This condition is frequently, although not always, associated with wide inguinal rings and probably develops in the early years of life.

The acquired predisposition to hernia is the result of general physical weakness, especially in young children under unfavorable nutritive conditions. Besides this there is the influence of chronic diseases associated with emaciation. The fat disappears from the meshes of the cellular tissues, which in turn become lax and movable, so that the so-called hernial openings are insufficiently plugged. The effect of emaciation is greater when the patients were previously extremely obese, because the tissues were more or less spread apart by the deposit of fat. The greatest acquired predisposition is found in advanced

years, when there is physiologically considerable diminution of tissue associated with relaxation of muscles and fascia. For this reason in senile individuals it is extremely common to have multiple ruptures develop without apparent cause. During old age or after disease the lower portion of the abdomen assumes a more or less characteristic shape as the result of relaxation of the anterior abdominal wall. The upper portion of the abdomen is flat, and in the lower portion of the linea alba and on both sides above Poupart's ligament there is a rounded bulging of the thinned-out abdominal wall. Berger describes another variety in which the lower portion of the abdomen is distended and the upper flattened out. The parietes are thin, and at times the intestinal loops may be distinctly seen and felt through the skin. The abdominal wall may be so distended as to hang down over the pubes onto the thighs like an apron. This apron, to be sure, consists only of skin, but the condition is associated with stretching and relaxation of the muscular portion of the wall. Individuals with abdominal walls of this sort, especially old women that have borne several children, not infrequently have several large hernias, and there is apt to be ptosis of the abdominal viscera, such as prolapse of the uterus, of the vagina, or of the rectum, or floating kidney and enteroptosis.

The conditions associated with extreme distention of the entire abdominal cavity and stretching of the abdominal wall have an especially deleterious influence. Pregnancy heads the list in this direction. The stretching affects the portions of the abdominal wall that are nonmuscular just as much as if not more than the muscular regions. After delivery these regions are overstretched and relaxed. In healthy individuals they regain their normal consistence after a sufficient rest, but if disturbances occur before the region is restored to its former state, it is evident that severe damage may result. When an individual becomes pregnant in rapid succession, the abdominal walls do not have time to regain their normal resistance. These remarks are well illustrated by the separation in the umbilical region and in the linea alba between the rectus muscles during the last stages of pregnancy. The reason why a hernia does not develop more often immediately after pregnancy is probably due to the facts that most women take especial care of themselves after delivery, and that the amount of interabdominal pressure during this period is slight. Besides, the effect of abdominal straining, which is of etiological significance in many cases, is much diminished during the puerperium.

Certain individuals have an abnormally long mesentery, and it may be that the pressure of a dependent and filled portion of intestine weakens the lower part of the abdominal wall. Radical operation, however, shows good results in these cases, so that the significance of a long mesentery does not appear to be great. Subserous lipomata, especially if they tend to wander, form another predisposing cause. Pelletan and Cloquet called attention to the fact that certain cases of hernia were not the result of a protrusion of the peritoneum, but that the peritoneum was pulled out after a lipoma. Contracting lymph-

glands are also supposed to exert similar traction upon the peritoneum, just as traction diverticula of the œsophagus are the result of cicatricial contraction in the vicinity. The lipomata are found especially in the femoral region. They tend to exert traction on the peritoneum and form a funnel into which the viscera later are forced. It is also possible that the abdominal rings may enlarge as the lipoma increases in size, and that they therefore offer less resistance. This etiology does not apply universally, although Roser and Linhard claim that femoral hernia is due to one or the other of these causes. These authors claim that when the lipomata could not be found, they were present in the early stages but later disappeared.

All of the above-mentioned factors are predisposing causes, while the actual appearance of a hernia is due to some accidental impulse that as a rule increases the abdominal pressure. Straining at stool, coughing, lifting, or a blow or fall upon the abdomen, are factors to be mentioned in this connection. Individual anatomical peculiarities are of considerable importance, because certain people do the hardest kind of work and are subjected to all kinds of accidental influences without ever having hernia, while others develop several hernias at one time as a result of insignificant accidents. Occupation is of considerable etiological significance, and those that follow an occupation which tends to increase the muscular power, combined with considerable strain on the thoracic viscera, are especially prone to hernia. An occupation which necessitates standing predisposes much more than sessile work, and occupations which require the use of considerable muscular force with the body bent forward favor the occurrence of hernia. Berger's statistics illustrate those occupations which are most conducive to hernia and those with which a hernia is not so common. The repeated increase of pressure associated with continuous coughing in chronic diseases of the respiratory organs, such as bronchitis, emphysema, and tuberculosis of the lung, is of especial importance. Certain authors claim that diseases of the nose and nasopharynx are of etiological importance, and it is quite certain that chronic constipation must be a predisposing cause, although there are no statistics in this direction. Difficult urination, such as is observed in connection with stricture of the urethra or hypertrophy of the prostate, is also of importance. Ravoth, Schmid, and Karewsky claim that phimosis is a predisposing cause in young children, whereas Englisch, B. Schmidt, and others deny any connection between the two conditions. Personally the author believes that phimosis does have some influence, and before fitting any appliance he always recommends circumcision in children with phimosis. It is not the obstruction to the passage of urine, but the irritation to the glans and prepuce which is associated with the desire to pass urine and straining when there is very little urine in the bladder. Several factors favoring the development of a hernia may be present at the same time. There may be some peculiar inherited shape of the abdomen, or wide rings, extreme mobility of the peritoneum, insufficient fixation or ptosis of the viscera, frequent sudden increase

of the abdominal pressure, and when there is marked predisposition a very slight accidental cause may be sufficient to produce a hernia. On the other hand, there may be no predisposing factors whatever, but a combination of accidental causes may be followed by the development of a hernia. There is considerable discussion as to whether a hernia can appear suddenly in all its component parts. The majority of authors believe that this is an extremely rare occurrence, although it is not uncommon to have patients state that the condition appeared suddenly while at work.

Kingdon's statement, that a hernia is a disease and not an accident, a pathological condition and not merely a mechanical lesion, applies to most cases of rupture, for if the condition appeared suddenly the physician seeing the case immediately would usually find evidence of more severe traumatic injury. It is perfectly possible that a hernia may have been gradually developing for some time, and that owing to some accidental cause it suddenly increases rapidly in size and becomes evident on inspection. It is quite common in young boys to have a loop of intestine come down suddenly in a vaginal process that has been open since birth. It is not uncommon, also, to have recurrence after a radical operation appear all of a sudden, although this is not the usual procedure. The vast majority of acquired hernias in adults develop very gradually.

It is a matter of indifference whether the pressure in the abdominal cavity is perpetually positive or not. (Braune, Schatz, Schwerdt.) The pressure is increased normally only when the abdominal muscles contract all together. Under the influence of abdominal straining the space is considerably diminished and the movable viscera will escape toward the regions that are not diminished in size by the muscular pressure. This sliding away of the intestine will be more forcible the more sudden the muscular contraction; for instance, in attacks of coughing. This is illustrated while watching a hernia come down during an attack of coughing, or by placing the hand within the vagina or rectum. The effect of increased abdominal pressure depends largely upon the position of the body and the degree of contraction of individual groups of muscles. Certain individuals assume a position which places the minimum amount of tension upon weak spots, and they also avoid certain harmful influences. The accidental force is applied as a rule in an unexpected and uncertain way, while the body is in an unprepared and awkward position. The uncomfortable feeling in the lower portion of the abdomen while lifting with a fixed diaphragm heavy objects is not so much due in all probability to muscular strain as to the pressure and stretching of the peritoneum. The influences that result in a hernia may be minimal at the time, but repetition finally results in hernia. A harmful cause may act many times without damage. Eventually, however, the peritoneum may be loosened, and if sufficient time does not elapse to have the former condition restored before the cause becomes operative again, then a slight bulging in the region will result. Once this is present, the slight

amount of force which in former times did no harm whatever is effective in distending the pocket more and more. In a fully developed hernia the same loop of intestine appears again and again in the sac, and although it is difficult to prove, the same loop was probably effective while the hernia was developing. The fact that most individuals are not aware that a hernia is developing is greatly in favor of the theory that the early stages appear very gradually. Of 1042 subjects that presented themselves for examination because of an inguinal hernia, there were only 12 that appeared in the very early stages, and only 48 where the inguinal hernia was not complete, which would tend to show that the early stages of the hernia are overlooked by the majority of individuals, and that the patients are not aware of the condition until the hernia is perfectly evident to everybody. There are certain cases, however, in which the hernia is forced down suddenly (hernie deforce). Of the 4621 cases examined by Berger, 30.8 per cent.—*i. e.*, 1427—attributed the condition to violence; and of these, 1350 were inguinal hernias and 38 were femoral. Only 6 to 7 per cent. of hernias due to violence appear immediately after an accident. A slight pouch in the peritoneum may have been present for some time, but in 90 of 100 cases the bulging will take place gradually, in 9 it will come down in more or less abrupt stages, and in 1 case it will come down suddenly as the result of some applied force. A workman in lifting a weight experiences a sudden sharp pain in the inguinal region and appears for examination with a small hernia containing intestine. Practical experience and scientific investigation show that this workman would not have had a hernia as the result of lifting the weight provided there had been no hernial sac, which reached down almost to the external abdominal ring. This bulging of the peritoneum as far as this region is not the result of one sudden accident, but is the result of predisposition and a series of greater or lesser accidental causes. The final appearance of an inguinal hernia that can be appreciated on inspection is the result of a sudden exertion, but only after the way has been prepared in the above described manner. From a medical standpoint no objection can be raised to this view, although the legal side is quite different.

A hernia is a condition which not infrequently interferes largely with the earning-capacity of an individual, even if the rupture is held in place by a suitable truss. Generally an individual with a hernia that can readily be retained in place by a truss can perform only 85 to 90 per cent. of the work he was formerly capable of doing; and when the hernia is difficult to hold in place, his wage-value may be lessened to the extent of 50 per cent. Only a very small percentage of hernias are the immediate result of accident. The physician on the first examination should question the patient carefully to determine whether the cause as given by him can be classed as an accident. A blow or a fall upon the abdomen, slipping or falling while carrying heavy weights, with the body in an awkward, unnatural position, especially with the legs spread apart, inordinate taxing of the physical strength

while lifting, especially when several workmen are carrying a load and one or more drop the weight or cease to apply any force so that the strain falls upon the remaining individual, all of these conditions come under the head of accident. If physical work is given to an individual disproportionate to his strength because of his age or because of some usual occupation, this cause should also be considered under the head of accidents.

There are no symptoms characteristic of a hernia due to accident, and the author has never been able to trace a case in which there were signs of acute trauma, such as œdema and ecchymosis. A case reported by Stucki is interesting in this connection, and the recent work of C. Hägler treats of the question of traumatic hernia. The bruising of the abdominal wall, of course, has nothing to do with the hernia, and personally the author believes that a rupture may be pushed down by a sudden increase in abdominal pressure without shock or severe symptoms. Pain is usually present, and is due to stretching and traction upon the parietal peritoneum. If there has been a sudden jerk which pushes the hernia down for some distance at a time, the patient feels more or less nauseated and quits work for the time being so as to consult a physician. After several days, or even weeks, it is practically impossible to tell how a hernia appeared, whether it was due to accident or whether it appeared gradually in the usual way. It is possible that a hernia may be the result of accident in these cases if the outside portion is small and the hernia cannot be reduced immediately only after prolonged pressure and reappears on coughing. A small inguinal ring and unilateral hernia are also somewhat in favor of a traumatic origin. Against a sudden development of the hernia would be the size, so that the hernia reaches down into the scrotum; also considerable mobility, perhaps so much that the hernia can be reduced while standing up and easily while lying down, and reappears immediately. If other ruptures are present at the same time, this does not exclude a sudden appearance of the condition because of the possibility of individual predisposition, but is is more in favor of gradual development. If the patient comes under observation several weeks after being attracted by the condition, the chances are that the first symptoms noted by him were slight, because if they were violent and due to accident, he would in all probability have applied to a physician immediately. Not infrequently a hernia is claimed to be the result of violence, such as a blow upon the stomach or a kick. This is, of course, possible, but an examination of these cases immediately after the injury is of extreme importance, as are also the peculiarities of the individual's abdomen. In Russia it is not uncommon for young men who wish to escape military service to enlarge the inguinal canal and stretch or rupture the external ring, which favors the development of a hernia. These cases are easily distinguished from hernias that develop in the usual manner, because the external ring is usually irregular, jagged, and infiltrated, with signs of inflammation or unusual openings in the aponeurosis of

the external oblique. These cases add in no way to the knowledge of the manner in which the usual forms of hernia may develop.

PATHOLOGICAL ANATOMY OF HERNIA.

A hernia consists of a ring, a sac, contents of the sac, and overlying tissues.

Hernial Ring.—Although a rupture may occur in any part of the abdomen, as a rule they are found in certain definite regions. Hernial rings do not exist in normal individuals and are always pathological. The reason why certain regions of the abdominal wall are more liable to hernia is that the tissues in these regions are not firm and are more liable to give way to applied force. Every individual has weak places of this sort, although they vary greatly in different persons. They have been divided into two groups:

1. The regions of the abdominal wall that are weakened by the vessels or other structures leaving the parietal cavity so as to reach the surface of the body. To this group belongs the place of exit of the cord or round ligament, the femoral vessels, the umbilical vessels, the obturator vessels, and the gluteal arteries.

2. Regions of the abdominal wall where certain layers are absent, or at least weaker, such as the internal inguinal fossa, the linea alba, the spaces between the muscles of the lumbar region, on the floor of the pelvis, and along the outer margin of the rectus abdominalis. All of these places are more or less pliable, and sometimes they are abnormally so. While a hernia is developing, the canal may at first be of considerable length, so that one is justified in speaking of a hernial canal; but as the opening decreases in size this canal becomes shorter and shorter, so that finally there remains a more or less circular opening in the abdominal wall, which is spoken of as a hernial ring.

Hernial Sac.—The immediate covering of the structures contained in the hernia is called the hernial sac. It consists of a bulging outward of the parietal peritoneum without solution of continuity. The peritoneum bulges outward and displaces the surrounding peritoneum from the immediate vicinity because it is only loosely connected to the parietal wall proper. If a rupture takes place through a small opening, there are, of course, folds at the mouth of the hernia which smooth out when the hernia is reduced. With recent hernias these folds are sometimes quite distinct; but when the rupture has existed for some time, the approximated surfaces become united and the folds are no longer to be detected. This alters the sac in the region of the hernial ring in such a way that it becomes thicker and more resistant than the remaining portion of the sac and retains its shape even when the sac has become completely free. This portion is called the neck of the sac. In addition, surgeons speak of the mouth and the fundus of the sac. In recent hernias the sac may be dome-shaped, especially in the inguinal region, with the base toward the mouth. Later it becomes

cylindrical, sacculated, or irregular, and sometimes there are subdividing bands that start from the apex of the hernia.

Certain hernial sacs have constrictions with intervening dilated portions. This variety develops when more resistant portions of the sac alternate with pliable regions that are distensible on pressure. In congenital hernias there may be circular constrictions that are considered to be due to points of partial obliteration of the processus vaginalis. In other cases the entire sac with the neck is displaced farther downward. The original neck remains tight and a new neck with an intervening distended portion develops.

The sac itself, consisting of parietal peritoneum, has all the peculiarities of any serous membrane, is always smooth, shiny, and covered with a slight amount of moisture. It consists of a connective-tissue base with numerous elastic fibres covered with a single layer of squamous endothelium. This endothelium is subject to all the specific peculiarities of these cells and shows a tendency to secrete an excess of serum, to form fibrinous deposits, and to become united and adhere. In old sacs the primary nature of the hernia may be difficult to recognize, although any changes present should be explained as modifications of the primary membrane.

In recent hernias the internal surface resembles normal peritoneum. In old sacs the color is usually grayish and the serosa is more or less fibrous in nature. Certain regions show grayish-black points indicating old hemorrhages. Sometimes portions of the sac become as hard as cartilage and calcium salts may be deposited, erroneously considered to be ossification. Besides these changes there is thickening due to chronic inflammation or there may be a fresh fibrinous deposit which is either absorbed or becomes organized in time to form a pseudomembrane. A fibrinous deposit of this sort may be followed by adhesions between the sac-walls and complete obliteration of the cavity. In other cases the sac contents become so firmly adherent that it is impossible to separate the sac from the contents without injuring the latter. Adhesions of this sort may with time be drawn out so as to form long, thin strands, while in other cases the structures may remain adherent over large areas.

When the hernia is kept reduced, the sac may be obliterated by adhesions, the entire structure being changed to firm connective tissue. In other cases only the neck of the sac becomes shut off and the fundus fills with serous fluid, giving rise to so-called hernial cysts. Sometimes a fresh hernia takes place above a cyst of this sort and the relations become considerably complicated. The new hernia may settle down into the cyst, which surrounds it, and the condition is then called encysted hernia, a name applied by Cooper.

Not infrequently sacless hernias are reported. These may occur under two conditions. If the external covering and the sac itself have become destroyed, the contents may be covered with scar-tissue, which can be the only covering of the hernial contents. Again, a fresh hernia might develop should the suture in the peritoneum after a

radical operation tear out, in which case the new hernia will have no peritoneal covering. Special attention will be given to those hernias containing viscera that are not freely movable in the abdominal cavity, but are partially fixed. These reach the hernia when the sac becomes larger and larger, and drags down with the parietal peritoneum organs that are partially covered by this and firmly attached to it. If the cæcum, for instance, is found in a scrotal hernia, it is usually possible to reach the gut directly without opening the sac. This can usually be done from behind. The same applies to the ascending colon, the descending colon, and to the bladder. These organs maintain the same relation in the hernia to the peritoneum that they normally have in the abdominal cavity. It is possible even in a normal cæcum to open the intestine without opening the peritoneum; but if one intends to open the surface of the cæcum covered by the peritoneum, it is necessary to open the peritoneal cavity, and in a rupture, of course, the hernial sac. There is really no sacless hernia, but some organ is included in the rupture which is only partially covered with peritoneum. The sac may lie to one side or behind. W. Koch considers that all of these cæcal and large intestine hernias are really congenital. It may happen that the peritoneum forms a rupture without there being any hernial contents. To this group belong the patent vaginal process in males, the diverticulum of Nuck in women, and the prolongations of the peritoneum connected with a subserous lipoma. Rokintansky and Lainhart have described congenital diverticula of the peritoneum in the inguinal and crural regions. Englisch has described pouches of peritoneum varying in size and found in individuals well advanced in years in the region of the internal inguinal fossa.

Hernial Contents.—Viscera, fat, and cysts. A hernial sac becomes a rupture as soon as it contains viscera. Almost all of the abdominal viscera have at one time or another been found in the sac. One or more viscera may be contained in the sac at the same time. Sometimes the majority of the abdominal viscera are contained, a condition known as eventration. According to the seat of the hernia, there is considerable variation in the contents, but it is far more common to find intestine or omentum. As a rule the same piece of intestine probably always comes down in a hernia that can be reduced, but with time changes are apt to take place that fix this piece of intestine. Maydl found that in 283 inguinal hernias intestine alone was present 149 times, the omentum 77 times, and both 34 times; 123 femoral hernias contained the intestine alone 86 times, the omentum alone 19 times, and both 14 times. In 11 umbilical hernias the intestine was found alone twice, the omentum alone 3 times, and both 6 times. It is therefore much more common to have intestine in a hernia, and in the majority of cases the small intestine, because it is much more movable. The mesentery is longest about one-fourth of a metre (10 inches) above the ileocæcal valve, and in the region of the cæcum the mesentery is much shorter. In most cases a loop of intes-

tine will be found in the sac with a portion of the mesentery. Sometimes there are several loops, and when gangrene occurs four or more open ends may be found. If a portion of the intestine has remained in the hernia for a considerable length of time and tends to become lower and lower, the mesentery lengthens, and in certain cases of inguinal hernia the sac reaches as far down as the knees. Sometimes the sac does not contain a complete loop of intestine, only a portion of the gut-wall. The following types of lateral intestinal hernias should be sharply distinguished:

1. **Congenital Intestinal Diverticula (Meckel's Diverticulum).**—At the seat of origin this structure is usually covered with all the normal intestinal layers and is about the same size as the ileum. It is a remnant of the communication between the intestine and the vitelline duct, and can be found therefore only in one place and is always single. Littré first described a hernia of this sort, and the term "Littré's hernia" should only be applied to this variety, although it has been used in connection with almost all parietal hernias.

2. **False diverticula**—*i. e.*, a bulging forward of the mucous membrane through the muscular layer—is a condition found frequently in the small and large intestines. These bulging areas are usually found in the lateral portion of the intestine near the mesentery. They have erroneously been considered to be due to this portion of the intestine being forced down into a hernial sac. These false diverticula, however, are often found in great numbers even without any hernia.

3. **Hernia of the Intestinal Wall; Lateral Hernias.**—In these cases the sac contains only a portion of the intestinal canal, usually the convex portion—*i. e.*, the part farthest away from the mesentery. If a piece of intestine of this sort has remained for a considerable time in the hernia, it may become constricted and leave a permanent bulge, which appears to be completely tied off. This condition may closely resemble a true diverticulum. The latter condition will be considered in connection with strangulations. The transverse colon, when contained in a hernia, presents conditions that resemble the small intestinal conditions quite closely. This portion of the large intestine frequently has a very long mesentery, and forms a loop which is V-shaped or M-shaped and may reach down as far as the symphysis. It is very movable, as is also the sigmoid flexure, which is also frequently found in hernial sacs. Portions of the large intestine that are more firmly fixed can reach the sac only when there are abnormal relations of the parietal peritoneum. Maydl found 22 hernias of the large intestine in 443 cases, 11 of which involved the cæcum.

It is, of course, evident that the appendix may be in the sac alone or with the cæcum. Even the stomach has been found in large umbilical hernias and in inguinal hernias, and it is not uncommon to have a small corner of the stomach in an epigastric hernia. Thoma reported 22 cases of stomach hernia in 1885; 15 of those were epigastric hernias, 3 umbilical hernias, and 4 scrotal hernias; 6 of the number had become strangulated.

Next to the intestine, the omentum is found most frequently in the hernia. In children the omentum is a very short triangular affair, with the base toward the stomach and the apex toward the left. It does not reach even as far as the umbilicus, while in adults it covers all the intestine and has an irregular free margin below. The lateral margins not infrequently have elongated tabs, and the one on the right side has been called the ligamentum colicum. In umbilical hernias it is uncommon not to find the omentum in the sac, and in inguinal and femoral hernias it is frequently found, although it is changed in consistence and rolled up so that the individual folds have had an opportunity to become adherent (nodular thickening or hypertrophy of the omentum). The mass is not infrequently adherent in the sac, but rarely to the intestine. The fat in the omentum is increased and the vessels are considerably distended, although in some cases all the fat in the omentum disappears, so that all that is left is a connective-tissue strand. Brunner collected 180 cases in which the bladder was found in the hernial sac. Of these, 136 were inguinal hernias, and 122 males. Both sides were about equally affected. In 5 cases the hernia was bilateral. Of the 29 femoral hernias, 27 were in women, and of these 22 were on the right side, only 5 being on the left side. There were 8 cases of perineal hernia and 7 of other varieties. Certain of these hernias consisted of a portion of the bladder-wall not covered by peritoneum, and must therefore be considered to be a prolapse of the bladder. As these ruptures increase in size the portion of the bladder covered by peritoneum distends and the wall of the sac will be made up partly of the bladder, just as in the case of the ascending colon. The hernial cavity proper may contain loops of intestine. Brunner distinguished an intraperitoneal variety where the misplaced portion of the bladder was entirely covered by peritoneum, and an extraperitoneal variety—*i. e.*, prolapse of the bladder—without any peritoneal covering; besides a paraperitoneal kind where there was a distinct hernial sac besides the bladder. This latter variety is more common, and of the 180 cases 5 were intraperitoneal, 18 were extraperitoneal, and 100 were paraperitoneal. It is very common to have a vesical hernia surrounded by a thick layer of fat which is intimately adherent to the bladder, so much so that the bladder-wall has been torn during an attempt to strip off this tissue. Many of the cases of hernia of the bladder reported in literature have been secondary to an operation, for the bladder-wall was pulled down into the hernial opening by excessive traction on the sac. The female genital organs, such as the ovaries, tubes, and uterus, are not infrequently found in hernias. The ovaries are found most commonly, and reach the sac in a similar way as the testicle, so that one might speak of descent of the ovary and a processus vaginalis. The upper portion of an ovarian hernia is probably congenital, is frequently bilateral, and associated with other malformations of the genitals. Puech collected 86 cases of ovarian hernia and found that 54 were congenital, and 33 of these were associated with other malformations. Most congenital

ovarian hernias are irreducible and the ovaries are frequently diseased. Englisch found in his 38 cases that they were inflamed 17 times, cystic 5 times, carcinomatous once, and normal in only 15 cases. Inflammation may readily take place, and hernias that were originally movable become fixed. The processus vaginalis never closes behind the ovaries, although it is uncommon to have other abdominal viscera follow down behind the ovary. In acquired hernias, on the other hand, the ovaries are apt to be followed by the tubes, and even by the uterus. Certain of these ruptures undoubtedly develop by the broad ligament, or part of it, becoming part of the wall of a hernia, and when the uterus is found in the sac this seems to be the only feasible explanation, at least the uterus has never been found without the ovaries and tubes. It is rare to find the tube alone in the sac, although Cruveilhier assumes that in ruptures containing the tube the ovary usually preceded this structure. Of the 13 cases reported, 9 were femoral and 4 inguinal hernias. The author found 17 cases of hernia of the uterus reported, 9 of the ovaries and tubes, 2 with the intestine, 3 had a double uterus, and 2 a uterus unicornis. In L'Allemend's case an entirely normal uterus was found in a femoral hernia, and this particular uterus was pregnant. Other abdominal viscera have occasionally been found in hernias associated with considerable loosening of the connective-tissue base. The liver is found especially in diaphragmatic hernias, although it has been found in congenital umbilical hernias, and is then peculiarly lobulated. Cases have been reported in which the gall-bladder and the spleen were found in inguinal hernias. (Skey, Lanz, Kuysch.) Even the testicle when undescended may be found in a hernia associated with displacement of the corresponding portion of the peritoneum. Guincort reports a case in which a testicle became strangulated in a femoral rupture. Deipser found a strangulated movable kidney, and Reichel a dilated ureter in an inguinal hernia. Rose found the pancreas in a large acquired umbilical hernia. This had gradually been pulled into the sac by the large intestine, which was adherent to the sac-wall.

Fatty Hernias and Cysts.—Fatty hernias are found in the places where rupture is common, and not infrequently they are confounded with a hernia proper or complicate an operation considerably. They have been described by Littré, 1700; Cloquet, 1819; Roser, 1850; Wernher, 1872; Englisch, 1886. There are certain regions of the abdominal wall where considerable subserous fat accumulates. This may at times form tumor-like masses, called subserous lipomata, that vary in size, and may be as large as a hen's egg. These masses of fat are found rather constantly in the linea alba, in the true pelvis, around the bladder and rectum, and in the region of the seminal cord and along the sheath of the femoral vessels. These lipomata are frequently covered with a membrane derived from the fascia, which on operation may be mistaken for a thin hernial sac. These tumors are in no way connected with the peritoneum, although in some cases they

are united by vessels from the first. When one of these subserous fatty tumors increases in size, it remains *in situ*, or it becomes displaced outward through some gap in the fascia, usually at the side of the large vessels. When this takes place, the peritoneum, if adherent, is subjected to considerable traction, and a conical bulging takes place which may form a hernial sac if it increases in size. This lipomatous hernial sac may undergo secondary changes, for the individual lobules of fat may grow in toward the interior of the sac and diminish the lumen. Finally the sac itself becomes completely obliterated, and all that is left is a very minute communication with the peritoneal cavity, or perhaps only a very thin connective-tissue strand, representing the only remnant of the former lumen.

It may also happen that the cavity becomes shut off from the general peritoneal cavity at a time when the hernial sac is still lined with a serous membrane. This is apt to happen when the walls of the sac become adherent around the margins of the opening. Fluid collects in this cavity and cysts develop that are single or multiple, and which may eventually be covered with a new hernia. It is evident that the conditions found may be extremely complicated, and inflammatory processes may appear in these cavities that produce severe symptoms resembling those of a strangulated hernia. One should always bear in mind that there may be a strangulated hernia in a secondary sac behind an inflamed cyst.

Accessory Coverings of the Hernia.—The external coverings of a hernia—*i. e.*, those between the sac and skin—vary considerably. In certain hernias, such as umbilical hernias and femoral hernias, the sac lies immediately beneath the skin, to which it is sometimes adherent. A recent hernia, however, is apt to be covered with fascia, fat, aponeuroses, or muscles. A hernia makes it way through these tissues, and a certain number of these form parts of the external covering. These conditions cannot be carefully sought for at every operation, because the tissues are sometimes thinned, sometimes thickened, sometimes matted together in a firm mass so that they cannot be distinguished. Most ruptures are covered with at least one layer derived from the intra-abdominal fascia, such as the transversalis, the iliac, the sacrolumbar, or the pelvic, etc. The name fascia propria herniæ has been applied to this layer, and may be retained if its origin is borne in mind.

SYMPTOMS AND DIAGNOSIS OF HERNIA.

In the vast majority of cases the diagnosis is easy, although it is not uncommon to find cases in which the condition can be recognized only after a most careful, methodical examination. Generally speaking, a rupture is recognized as such when the contents of some abnormal tumor-like swelling of the abdominal wall can be pushed back, or when it is possible to detect that the contents are some organ which

normally belongs in the abdomen. If it is possible to reduce the hernia, it is usually possible to follow the hernia up with a finger and detect the route that the rupture has taken and determine the length, direction, diameter, and nature of the wall of the canal. If the finger is left in the hernial opening, an impulse will be felt on coughing, and the hernia will reappear when the finger is removed. After replacing the hernia, the sac formed by the peritoneum can generally be recognized by the movableness of the inner surface.

When it is not possible to reduce the swelling, it must be possible to demonstrate some communication with the abdominal cavity provided the condition is to be considered a hernia. A peduncle should be sought for, and the direction, shape, and consistence of this should be investigated as far as conditions allow. The most important point in these uncertain cases is that there may be considerable variation in the volume of the mass. When standing erect, straining, coughing, etc., there will be noticeably increased tension, or some increase in the size of the mass. When lying on the back, the tension diminishes, and the increased tension due to straining associated with an increase in size may usually be overcome by direct pressure upon the tumor. Even when it is impossible to detect any change of size and tension, due to voluntary acts, it may be possible to demonstrate that the volume and tension of the mass change before and after eating. In the evening the rupture is usually larger than in the morning. Sometimes it may be possible to detect the intestine or the omentum in the sac. The intestine appears as a uniformly rounded swelling which is elastic, though not very tense. This latter property differs according to the amount of straining and after a meal. When the hernia is very large, one may sometimes detect waves of peristaltic motion, which may also be produced by pressing upon the tumor or by rubbing it. If the percussion-note is tympanitic, one is fairly sure that the hernial sac is filled with intestine distended with gas. A dull percussion-note does not necessarily exclude the intestine. The intestine may be empty, or the contents may be fluid without any gas, as is frequently observed in irreducible hernias of the sigmoid flexure. The tympanitic note may also be modified by the overlying tissue. The gurgling that is felt and heard during reduction is of especial importance, although one should not confound these noises with similar sounds in the vicinity.

The omentum appears as an irregular, lobulated mass that may be more or less unfolded on palpation, which also has a peculiar granular feeling that is apt to be remembered as something more or less characteristic. The percussion-note is dull provided the sac does not contain intestine at the time. Any effort to replace the hernia should be done very slowly because the omentum goes back little by little and without gurgling. Considerable force is required to push back even the last portion. When both intestine and omentum are contained in the sac, the intestine always goes back first. Omental hernias are sometimes confounded with over-developed appendices epiploicæ, or with a hernial sac that is much thickened, although empty. The characteristic

granular consistence of the omentum is due to secondary changes, such as an overgrowth of fat, inflammatory thickening, and later cicatricial contraction of the connective tissue. If the omentum remains perfectly normal, it will feel smooth and soft as well as elastic.

It may be extremely difficult or almost impossible to recognize other organs within a hernial sac. In young girls an ovary may be recognized as an oval soft body that may be somewhat displaced but need not necessarily be completely reducible. Sometimes it is possible to detect a thick strand that extends upward or inward from the solid body. This represents the Fallopian tube. In adults the condition is frequently confounded with a hypertrophic omental hernia with a strand leading back into the abdominal cavity. If the contents of the hernia move with the uterus by examination through either the vagina or by rectum, it will in all probability establish a diagnosis. At times the ovary becomes painful and tender during menstruation, although this sign is by no means common. When the bladder is contained in the rupture, there are usually two parts: one lies within the abdominal cavity, and is connected with the portion within the hernial sac by means of an isthmus. Pressure upon the rupture will not infrequently produce a desire to urinate, and in rare cases, where the portion contained in the rupture is large, urine may be pressed out of the bladder. Sometimes it has been possible to inject fluid through the urethra into the portion of the bladder contained in the hernia. It is also characteristic that the hernia is larger when the patient has not urinated for some time, and is smaller after urinating, whereas in other cases the only symptom that attracts attention is difficulty of voiding urine while the urethra on examination is found to be perfectly normal. Certain patients help themselves in peculiar ways, especially by change of position while urinating. They may press upon the hernial sac or pass water in two portions while in different positions, the portion of the bladder lying in the abdomen being emptied first and then a second quantity after pressing upon the hernia. Sometimes cystoscopic examination will give valuable information showing that the interior of the bladder is displaced.

There are certain hernias that do not form any visible external swelling. Internal hernias that do not leave the abdominal cavity will not be considered in this connection; neither will those that enter the thoracic cavity through the diaphragm. Even the ordinary types of hernia—for instance, the inguinal hernia—are subdivided into hernia incipiens, hernia incompleta, and hernia completa, of which only the latter shows a swelling that can be detected externally. The symptoms of the first two depend entirely upon the variety of hernia, and will be considered later.

Immovable, Irreducible Hernias.—There are numerous hernias the contents of which cannot be replaced at all or only partially. These cases, in which it is very difficult to reduce the hernia, should also be included in this class, especially if they cannot be held back by any appliance. If the strangulated hernias are left out of consideration, it

will be found that the most frequent cause of irreducible hernia is some adhesion between the hernial sac and the contents of the sac. Berger's statistics include 10,000 cases of hernia, 582 of which were irreducible, and in these the omentum was the cause 318 times. It is, however, not uncommon to find adhesions between the intestine and the hernial wall without involvement of the omentum. Certain of these adhesions are congenital. There are congenital inguinal hernias in boys where shortly after birth the testicle becomes adherent to a loop of intestine, especially to the cæcum, while it is in the processus vaginalis. It is supposed that these adhesions form at a time when the testicle is in the abdominal cavity. Most of the adhesions, however, are due to inflammation, and are the result of some slight strangulation that has not been enough to shut off the intestine sufficiently to produce gangrene, or they are the result of fecal retention with secondary inflammation producing ulcers of the loop of intestine contained in the sac, and finally the condition is the result of long-continued pressure from ill-fitting appliances. Sometimes these adhesions unite only very small portions of the intestine with the hernial sac, and the adhesion becomes secondarily drawn out into a long, thin strand. There are, however, cases in which the intestine and omentum are adherent over considerable areas, so that there is almost no free space left in the sac. Usually, however, a portion of the hernial contents is movable and the remainder is tied down by adhesions.

Those cases in which some organ contained in the abdominal cavity, or in which the mesentery has been gradually dragged down on account of the increasing size of the hernial sac, are closely related to the cases above described. The respective organ forms a portion of the wall of the sac, and it is quite evident that this viscus cannot be replaced, because it is not freely movable within the sac.

Certain omental hernias undergo in their lower portion a peculiar hypertrophy as the result of congestion and inflammation, and a thick lump is suspended by a thin pedicle, and is therefore irreducible. This variety of omental hernia need not necessarily be adherent to the sac-wall, but it cannot be replaced because the mass in the lower portion is too large to pass through the narrow neck of the hernia.

Very large ruptures containing most of the abdominal viscera cannot be replaced because the abdominal cavity has diminished so in size that there is not room for the hernial contents. The hernia may be perfectly movable and may be partially reduced, but reappears immediately; the hernial contents, as it were, have lost their right to live in the abdominal cavity.

THE INFLUENCE OF HERNIA UPON THE GENERAL CONDITION.

Many individuals have a large hernia without being aware of the fact. They discover it accidentally or when some severe complication appears. Most hernias, however, attract the patient's attention to the condition sooner or later in a disagreeable manner. The early stages,

when it is difficult to discover any abnormality on examination, are apt to be characterized by a series of uncomfortable sensations which the patient himself is not very well able to describe. Some explain that they have a sensation of pulling low down in the abdomen combined with disturbances of digestion and attacks of vomiting. Some suffer only an uncomfortable sensation, which, however, has a certain influence upon their general temperament. In cases of this sort one should always suspect a commencing hernia, especially if the condition improves when the patient lies down or when pressure is made over the painful area of the abdomen with the flat of the hand. During the later stages the amount of discomfort depends upon whether the patient has worn a truss or not, and whether he has paid more or less attention to his condition. Anyone wearing a well-fitting truss may be perfectly free from symptoms, although it is, of course, necessary to modify the work and the food. Patients with irreducible hernias or hernias that cannot be held in place by a truss usually suffer from symptoms that gradually increase with the size of the hernia. There is almost always some disturbance of the bowels, and as a rule these cannot be emptied very well, because that portion outside of the abdominal cavity is not affected by straining. The muscles of the intestine compensate for this, to be sure, for a certain length of time by functional hypertrophy, which, however, does not last forever, and is frequently followed by degeneration and insufficiency. There then will be pronounced attacks of constipation alternating with attacks of diarrhœa. There may be eructations of gas, vomiting, nausea, distention, flatus, and colicky pains. The patients gradually become disgruntled, give no attention to the movement of their bowels, have no desire to work, and are liable to all infections.

TREATMENT OF HERNIA.

The treatment of hernia is palliative or radical. In addition there is the treatment of the complications to be considered.

Palliative Treatment of Hernias. Trusses.—Prophylactic treatment should be applied chiefly in the early years of life. A physician should always examine even a newborn child to determine the condition of the regions where hernia is likely to develop, and should then give necessary instructions to the mother and nurse. The care of the umbilicus and the early treatment of any increase in the umbilical ring, early reduction of phimosis, attention to digestive disturbances, coughs, prolonged crying, repeated examination of the inguinal region in children subjected to these conditions, and immediate treatment with the first signs of abnormality, are factors that should receive careful attention. Even later in life prophylactic measures may be of great value. Numerous difficulties that are more or less obscure are the result of the beginning hernia, and the prophylactic wearing of a truss may be of considerable value. Even when a hernia has become well developed, the avoidance of certain conditions and careful medical observation may be of extreme value.

The author considers such treatment palliative that influences only certain symptoms while being applied without removing the hernia; for instance, reduction and retention of the rupture. In many cases this treatment will be sufficient to enable the patient to perform his daily duties and protect him from severe complications. Palliative treatment is being supplanted by radical operation, and it is distinctly necessary that a physician should be familiar with the scope of palliative measures. Certain hernias are readily replaced, while others can be replaced only after using certain artificial means or after protracted treatment, and in some the hernia cannot be reduced at all, as has already been emphasized. Irreducible hernias containing intestine should never be subjected to the pressure of a truss. If only a piece of omentum remains in the hernial sac and the intestine itself can be replaced, it is sometimes permissible to use a hollow pad. Generally speaking, irreducible hernias, especially if they produce symptoms, are subjects for radical operation; and when this is not possible it is best to use some elastic appliance that at least relieves the condition and prevents rapid increase in the size of the hernia. If fortunate enough to be in touch with a skilful support-maker, it may be possible to construct a suspensory with elastic bands that prevents absolutely any increase in the size of the hernia and may even permanently reduce the size.

Reducible hernias may go back of their own accord if the patient lies down and does not strain. In certain cases it is possible to replace the hernia by simply squeezing the sac. Intestinal hernias are much more easily replaced than omental hernias, but reappear more quickly. Large intestine hernias are very apt to go back very suddenly as soon as a certain portion of the gas has been pressed out of the intestine. Sometimes reduction of a rupture is facilitated by previously emptying the bladder and intestine, and also by position. The abdominal wall should be relaxed as much as possible, the thighs should be somewhat raised, and the trunk may also be raised a little with the head down. Patients should not be allowed to bend forward and watch the operation, because this position almost always puts the rectus abdominalis under tension. In difficult cases it may be necessary to raise the pelvis and lower the trunk so that the hernia is the highest point of the abdomen. The sac should be compressed gradually, and one should not allow the hernia to spread out around the hernial opening. This is best done with one hand while the other compresses the sac. In certain cases it may be feasible to replace first a small portion of the hernia next to the neck, and then follow this by the remaining hernia little by little.

Reduction of large hernias that have been down for a considerable length of time may be associated with very annoying symptoms, such as a sense of unbearable tension within the abdomen, nausea, vomiting, weak heart action, unconsciousness, etc., signs that disappear if the hernia is allowed to come down again. In cases of this sort it may be necessary to undergo preliminary treatment before the hernia can be perma-

nently replaced. These individuals should be put on a very light diet for a certain length of time, their bowels should be kept open, and they should be kept in bed on their back for some time, while the hernia itself is subjected to some elastic pressure or while sand-bags are placed over the sac. Each successive day attempts should be made to replace the hernia, and within a few weeks it may be possible to keep the rupture back permanently. After the hernia has been reduced in this way a truss should be fitted, and if this is not immediately possible, the patient should wear a bandage with cotton pads. The chief appliance in palliative treatment of the hernia is a so-called truss, which was first introduced by Camper in 1785. A good-fitting truss should not annoy the patient, and should keep the hernia back during all ordinary exertion. The chief points of pressure are in front and behind, although the band itself should fit the contour of the body. Besides the spring and pad and the strap reaching around the opposite side of the body, it may be necessary to use shoulder-straps or perineal straps. The spring itself should be the chief factor, however, in holding back a hernia. The pad should reach beyond the margin of the hernial opening for about the width of a finger, and should not be conical, otherwise it would tend to increase the size of the hernia. It is best to have the pad fastened to the spring, otherwise the patient will change the position of the pad, which ordinarily is at an angle to the spring itself. When ordering a truss, the following factors should be taken into consideration: 1. The sex, age, and occupation of the patient. 2. Variety of hernia and side affected. 3. The size and direction of the hernial opening. 4. The circumference of the pelvis, between the anterior superior spine and the trochanter. 5. Individual peculiarities, especially the amount of adipose tissue.

The truss should be applied with the patient lying down. He should then be directed to stand up, and the instrument is tested to see whether it is efficient under ordinary conditions. The thigh should be held horizontally and freely moved about; then the patient should be told to climb upon a chair with the leg of the affected side first, and then climb down with the other leg first. He should be told to cough, strain, and overextend the trunk. If there is the slightest piece of omentum that cannot be reduced, the truss will be inefficient, or, if there is ascites and the fluid enters the hernial sac. In the aged with lax tissues all attempts may be futile. In these cases it may be necessary to operate or to use some form of suspensory; and it is a disadvantage to use large pads because the hernial contents may be flattened against the pubes or the hernia may be forced upward and is not visible on account of the size of the pad. The task of fitting a truss may be very difficult in obese individuals, for the opening of the hernia may be covered by the thick abdominal wall, while the inguinal region forms a deep fold. These patients should be made to wear for some time a spring with a pressure-pad, so as to diminish the amount of fat sufficiently to allow using a truss with a pad for the purpose of holding the hernia back. The skin in these cases should receive careful attention.

The truss should be applied immediately to the skin, and the patient should not be allowed to put it on over his shirt. It may in certain cases be best to use a tight-fitting garment underneath the truss, although it will always be possible in time to harden the skin sufficiently so that the truss can be worn directly over the skin. Tannic acid, alcohol, and astringents should be used to toughen the skin. The truss may be taken off at night when the rupture is easily replaced and has no great tendency to come down, or perhaps it may be well to use a truss with a weaker spring. In the early stages at least it is probably best to wear the truss at night until the hernia shows a tendency to remain reduced; but patients who cough at night should always wear their truss.

Generally speaking, trusses are palliative measures pure and simple—*i. e.*, they are only effective as long as they are worn. In certain cases, however, the prolonged wearing of a truss may result in a radical cure, especially during childhood and during the growing period up to about the twentieth year of life. The chances of a permanent result are more favorable the earlier treatment is commenced, for there is a pronounced physiological tendency to have the size of the umbilical and inguinal openings diminish during the first years of life. If in these cases there does not seem to be any tendency to have the cure become permanent in spite of careful treatment, there is usually some complication, such as adhesions with the hernial contents, for instance. The treatment may last from one month to a year, and should be aided by keeping the individual's nutrition in as favorable a state as possible, for not infrequently the hernia will stay back of its own accord when the tissue-spaces become filled up.

Radical Treatment of Hernia.—A hernia may be permanently removed in one of three ways:

1. By wearing a truss or some bandage. This method should be applied with youthful individuals, especially when the hernia can be easily reduced and held back.

2. By obliteration of the hernial opening by adhesive inflammation. This is an old method, but the subcutaneous injection of irritants is still used occasionally. Tincture of iodine was used by Velpeau, and Luton used perihernial injections of a saturated solution of sea salt. Schwalbe injected a 20 to 90 per cent. solution of alcohol. The skin is cleaned, the hernia reduced, and the left forefinger introduced into the hernial opening. The needle is pushed in to about the region of the pillars of the ring. One should wait to see whether blood flows from the needle or not, and then 1 c.c. of alcohol is injected in different places. These injections are made every day for two to three weeks, or at least every other day, and the patients should stay in bed so as to keep the hernia from coming down. After a few weeks this treatment may be repeated. The patient should keep very quiet, for not infrequently he has considerable pain. Abscesses sometimes develop after the injections. This method may be successful at times when the conditions are favorable, especially in youthful individuals, but

has no advantages compared with the radical operation of to-day. Lannelongue in 1896 recommended subcutaneous injections of a 10 per cent. solution of zinc chloride, 10 drops being used in different places, while the hernial sac and the cord are protected by a finger held in the ring. These injections are done at one sitting, under chloroform, and the solution is injected down to the bone and supposed to set up an inflammation that produces dense tissue, while the sac itself becomes obliterated. Lannelongue has never noted any severe complications aside from a moderate rise in temperature, and the results were favorable in 41 of 44 cases in which the patients were under twenty years of age. This method has not been sufficiently tested, but has a slight advantage over the alcohol method in that the treatment does not last quite so long.

3. Radical operation—*i. e.*, closure of the sac and hernial ring. Czerny's method, introduced in 1877, consisted in excising the sac and closing the ring by sewing the pillars together. This method is still made use of, but has been considerably modified, especially by Bassini. At the present time many surgeons believe that all cases of hernia should be operated upon at any time of life, and consider that the only counterindication is the coexistence of some disease that forbids operative interference. Most surgeons exclude those cases from operation in which the risk of the operation is great or in which the chances of a permanent cure are slight. The coexistence of any condition which renders the operation a procedure directly dangerous to life counterindicates in the minds of most men a radical operation. In this connection may be mentioned heart lesions, pulmonary conditions, bronchitis, debility, diabetes, kidney diseases, and the age of the patient. One does not like to operate on patients over sixty years of age, and some prefer not to operate under five years, because it is difficult to keep these young patients clean. There is abundance of experience, however, which shows that the danger from complications in children under five years is not great. It may be that some peculiarities of the hernia itself counterindicate an operation; for instance, when a large hernia has developed within a short time, due to abnormal weakness of the abdominal wall, or when the hernial ring is extremely large and the parietes are very lax, or when there are several hernias at the same time. In other cases, on the other hand, an operation is positively indicated, especially in strong, youthful individuals where palliative wearing of a truss has not produced a permanent result, and in adults with small ruptures and hernials rings that are not abnormally wide. It is evident, of course, that a radical operation should be performed when herniotomy has been necessary because of a strangulated hernia, provided the condition of the abdominal parietes permits. Trelat puts the indications tersely, and says that every hernia that cannot be easily completely and permanently reduced by some palliative appliance should be operated upon.

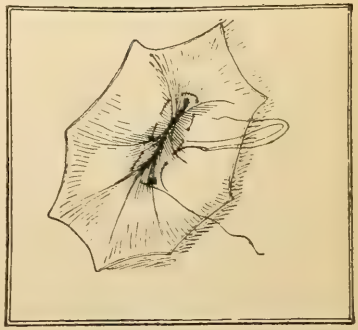
The greatest interest of a radical operation is attached to inguinal hernias in men, and will therefore be considered first. The chief indi-

cations are to obliterate the neck of the sac in such a way that after being returned to the abdominal cavity there does not remain a funnel-shaped bulging in the direction of the hernial canal. Furthermore, the hernial opening must be tightly closed. Any operation that leaves a portion of the sac in the hernial opening is to be condemned. The wound should be healed by first intention, because the larger the scar the less the resisting power. Complicated methods of operating have the disadvantage that the technic can never become common property of all operators, and that should the wound not heal by first intention the results are apt to be disastrous. One should always avoid operating in the dark—*i. e.*, the field of operation should always be completely and thoroughly exposed. The problem of permanently curing an inguinal hernia in a man always has the difficulty to overcome that an opening must be left for passage of the cord. Formerly this obstruction was overcome by castrating the man, a practice that has fallen into disuse.

A radical operation is only possible when the hernial content can be completely returned to the abdominal cavity or when it can be ablated. Adhesions between the hernia and the sac must be separated, and when thin they are easily torn, but when more extensive they may have to be dissected off. If they are very adherent, it may be necessary to excise a portion of the sac and leave it attached to the hernia itself. When a very considerable piece of intestine is not only adherent to the sac, but also bent and bound together, it may be necessary to resect a piece of the gut and do an end-to-end suture.

If there are extensive omental adhesions, it is best to ligate off the portion that has been down longest, in such a way that after being divided the stump will of itself retract into the abdominal cavity. The omentum is frequently very adherent, not only to the sac itself, but also to the abdominal wall around the internal ring. One should always separate these adhesions, although at times this is an extremely difficult operation. Even when the omentum is not adherent, it is generally considered advisable to resect a portion provided that extensive changes have occurred. It is equally important to separate the neck of the sac completely from the surrounding tissue. This should be carried out to the point where the junction between the neck of the sac and the parietal peritoneum is plainly visible. When there is considerable difficulty in separating the adhesions, one may be tempted to leave certain strands in the region of the internal ring untouched. This, however, is a great mistake because it favors recurrence in a large majority of the cases.

FIG. 228.



Tobacco-pouch stitch around the neck of the hernial sac.

The general technic is to expose the sac through a skin-incision over the hernial ring and separate the hernia from the surrounding

tissue. This may usually be done best in the immediate vicinity of the neck of the sac, because this can usually be found readily after dividing the superficial tissue. The accessory coverings of the sac are kept separated by means of a dry gauze sponge. If the cord is present as a rounded bundle, it is usually not difficult to separate the sac after dividing the tunica vaginalis communis. It is not uncommon, however, especially in congenital hernias, to have the structures of the cord spread over the sac as a thin layer, a condition that renders the operation itself much more difficult. Especially in the lower portion of the sac it may be so difficult to separate the tissues that it is wiser to be satisfied with complete separation near the neck, which can usually be done in spite of the difficulty. The sac is divided transversely and the stump allowed to retract into the abdomen. The lower portion is packed and then closed with secondary suture. In congenital hernias many surgeons recommend that the sac be divided close to the testicle and a new tunica vaginalis propria formed, while others remove the sac down to the point where it is reflected over the testicle. When it is very easy to replace the hernia, it may not be absolutely necessary to open the sac. On the contrary, it may be much easier to tie off the neck and replace the stump if this has not been done, especially if no abdominal contents appear in the neck. If there is doubt as to whether there are adhesions or not, one should always open the sac, but at a sufficient distance from the neck so as not to interfere with tying off. If it has been necessary to use considerable traction while separating adhesions around the internal opening of the hernia, one should always remember that organs connected with the peritoneum may have been pulled down, and that there is danger of injuring these while transfixing the neck of the sac. This happens especially in connection with the bladder and fixed portions of the intestine, such as the cæcum and sigmoid flexure. This accident has sometimes cost the patient his life.

If the hernial sac has been freed completely, it should be tied off on a level with the abdominal peritoneum. It is best to transfix the sac and tie both ways; and if necessary, the ends of the two ligatures should be tied again around the neck. Silk is the best ligature used, because it remains in place for a considerable length of time, and is not liable to cause trouble in this location. This method of tying off the sac applies only to small hernias, and when the hernial opening is considerably larger, as is frequently the case in inguinal hernias, it is better to close the opening by a pucker suture. The sac is put under tension in all directions, and the needle passed from without, taking up successive sections of the neck. The ends are then tightened and the sac tied off. When the hernia is extremely large, it may be difficult to close the opening in this manner, for the abdominal contents push down again and again. When putting this form of suture in place, one must be careful not to injure the cord, the epigastric artery, the bladder, or any portion of the intestine. This suture method should be used whenever it has been necessary to split the sac to such

an extent that it is impossible to apply a ligature safely, for in the latter case a slit is liable to remain internal to the ligature and give rise to trouble, and there is also danger of having the ligature slip and leave a large opening in the parietal peritoneum.

The surgeon should always avoid operating where he cannot see and control with the eye accurately every step. For this reason the method of exposing all of these tissues, even the internal ring, is considered justifiable, although it somewhat complicates the operation.

The treatment of the external wound differs in the hands of different operators. Certain surgeons claim that drainage is always necessary, because blood is liable to accumulate in the soft tissues of the scrotum and give rise to subsequent difficulty. Especial attention must be paid to check all bleeding at the time of operation as accurately as possible, and before closing the skin-wound one should always inspect the tissues carefully with reference to this point. When there has been considerable laceration of tissue during the operation, or when there is reason to suspect that the subsequent course will be unfavorable, it is much better to pack the wound rather than close the same completely with a suture. Even when suppuration does take place, it is not common to have the peritoneum involved, because the pus usually finds its way outward. Nevertheless in the loose connective tissue there may be long-continued suppuration that not infrequently is a source of considerable danger to the patient.

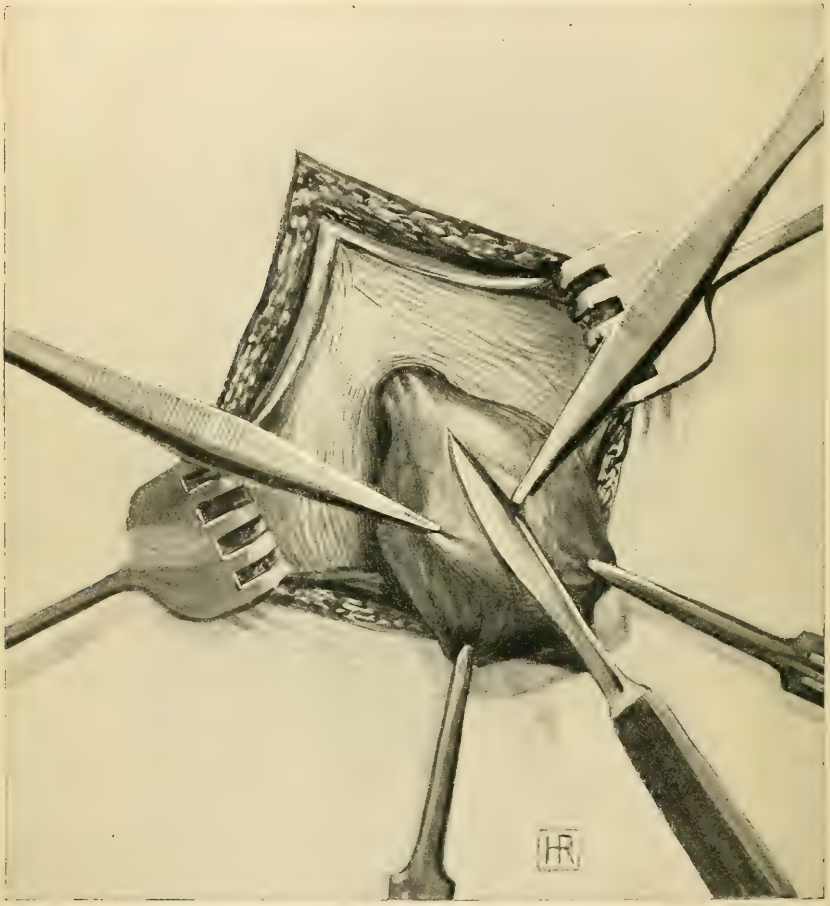
It is sometimes recommended to close the wound by means of a thin layer of iodoform collodion, which is perfectly justifiable if the operation was not difficult and the amount of laceration was slight. Whenever the hernia is large or the operation is difficult and prolonged, it is much better to apply a pressure bandage.

Methods of Operating.—Czerny's operation is the simplest, and is still used with certain modifications by many operators, especially in children. The sac is freed from the surrounding tissue, tied off, and dropped into the abdominal cavity. The two pillars are sewn together over a finger used as a guide, beginning from above. Formerly the edges of the pillars were not freshened, but now-a-days Czerny considers that the edges should come directly in contact with a band of the overlying connective tissue. Three to six catgut sutures may be necessary, according to the length of the canal, and care should be taken not to injure vessels, nor leave too small an opening for the cord, nor include the sheath of the rectus muscle. Küster modified this method by including not only the pillars of the canal in the suture, but also the floor and wall of the canal. All of these sutures are first placed and later tied. Bügner reports 67 patients with 68 hernias operated upon by this method, 61 of which—*i. e.*, 91 per cent. —never showed recurrence. Those that did recur were unfavorable from the first.

Championnière split the aponeurosis of the external oblique in the direction of the inguinal canal for the purpose of exposing the neck of the sac. In this way one may avoid leaving a funnel-shaped prolon-

gation of peritoneum, and the sutures may be placed close to the internal abdominal ring. Several layers may be used if necessary, so as to make the wound as firm as possible, and the split external oblique is closed again except for a small opening in the lower part for the passage of the cord.

Fig. 229.



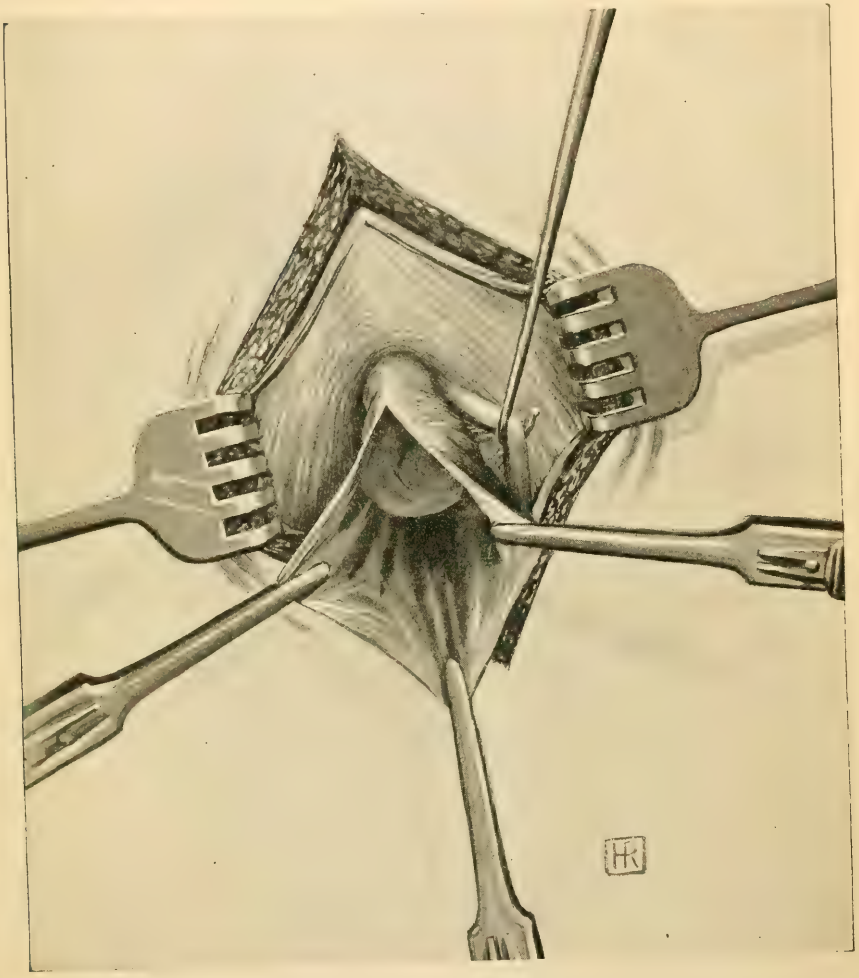
Operation for the cure of oblique inguinal hernia. The sac is pulled down toward the scrotum, exposing the neck, and is about to be incised. (Lilienthal.)

Hall recommends grasping the sac with a strong pair of forceps and twisting the same until it seems liable to tear. It is then tied off and the ends of the ligature are passed over through the upper, the other through the lower pillar of the ring, and then tied. The tension used is said to be sufficient to prevent any funnel-shaped prolongation of peritoneum and may smooth out any abnormal depressions in the vicinity. This may very well be for a short time after the operation, but after the tension has let up fixation of the stump of the sac within

the canal is an error, because it furnishes a guide, as it were, to any abdominal contents that have a tendency to come down.

Barker does not twist the sac, but passes the ends of the ligature through the margin of the internal abdominal ring and ties them over the external oblique.

FIG. 230.



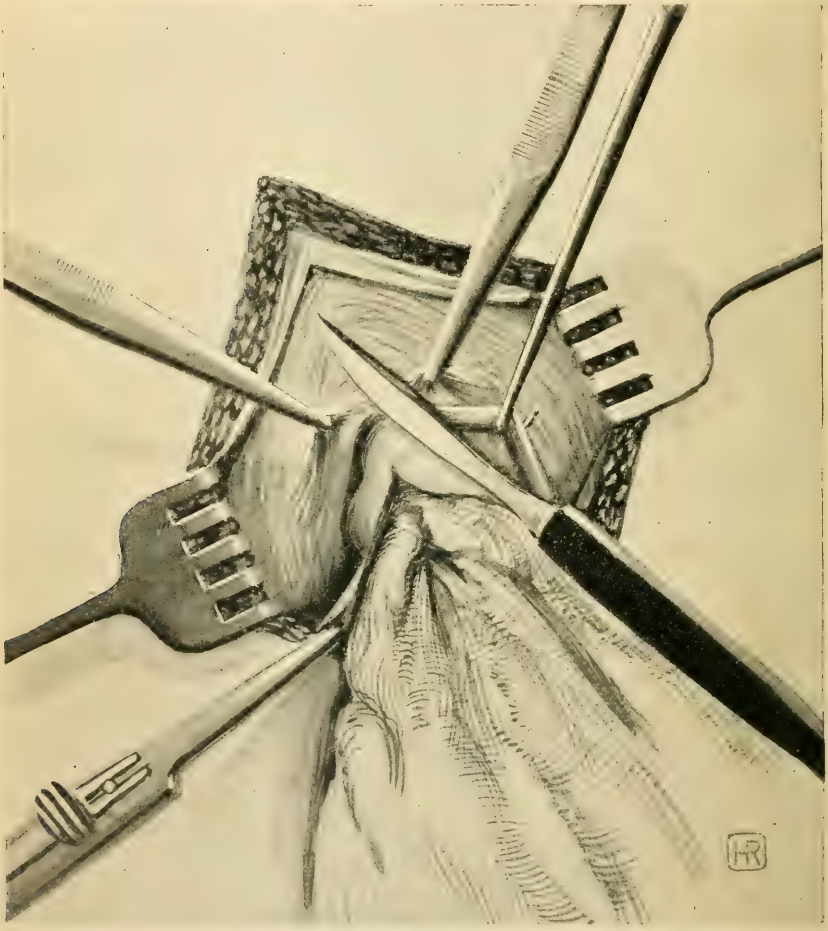
The sac has been incised, and is being held open with the aid of artery-forceps. The strangulated contents are seen. The spermatic cord has been freed, and is held up with a blunt hook. It is not always advisable or possible to isolate the cord at this stage of the operation. (Lilienthal.)

Rotter ties off the sac with a pucker suture, then carries the ends of the suture inward between the rectus and the peritoneum. He finally transfixes the rectus 2 to 3 cm. (0.8 to 1.5 inches) above the symphysis and ties the ends on the anterior surface of the muscle.

MacEwen does not remove the sac, but rolls it up into a sort of pad

which lies in the subperitoneal tissue. He then closes the hernial ring in a peculiar way which brings the walls of the canal close together. Autopsy reports show that this pad of peritoneum becomes completely absorbed, and in the author's opinion the good results of the operation are not so much due to invagination of the sac as to the efficient nature of the suture of the hernial ring. The efforts to close the hernial ring

FIG. 231.



The constricting tissues are being divided and the anterior wall of the inguinal canal slit up toward the internal ring. The gauze packing prevents prolapse of the abdominal viscera. (Lilienthal.)

with some organic material always met with the same result. The material becomes atrophied after a certain length of time, and this contraction favors recurrence. There are other methods of transplanting the hernial sac, such as those of Kingscote, Bishop, and Phelps. The author objects still more to the methods that leave the sac in the hernial ring as a plug. (Julliard, Terillon, Fergusson.)

Bassini's operation endeavors to restore the inguinal canal, whereby the posterior wall is made up of a muscle layer that is sewn together as tightly as possible. The skin-incision is made over the entire inguinal canal extending a little beyond the internal ring. The aponeurosis of the external oblique is exposed and split upon a director. The fascia is turned back and the cord, with the neck of the sac, is lifted

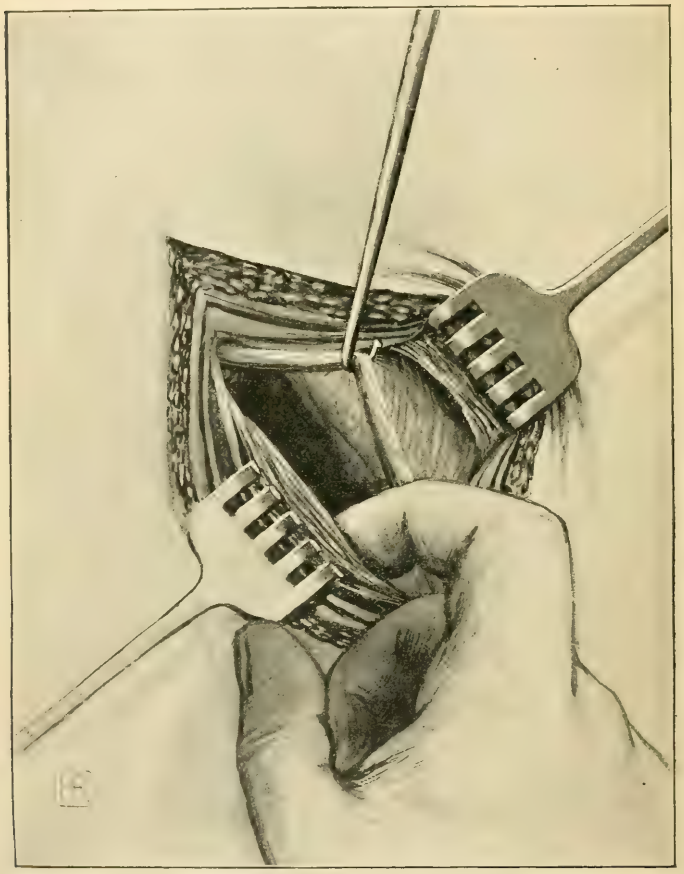
FIG. 232.

Its neck having been ligated, the sac is being ablated. The anterior wall of the inguinal canal has been opened. (Lilienthal.)

out. The cremaster is divided and the cord separated from the sac. No sharp instruments can be used, and the sac should be freed as far as the parietal peritoneum. If there is considerable difficulty in getting the sac off, the peripheral portion may be split and left in the scrotum. After opening the sac the hernial contents are reduced, the neck of the sac twisted once and transfixed; it is then tied off on both sides. When

the sac is very large or contains the cæcum, colon, or bladder, it it best not to use torsion, and to close the neck by means of a pucker suture. The stump should slip back readily into the abdominal cavity and not adhere to the margins of the ring. The cord is retracted upward and outward, and the fat and connective tissue are removed from the canal. The lower free margin of the internal oblique and transversalis are united by

FIG. 233.

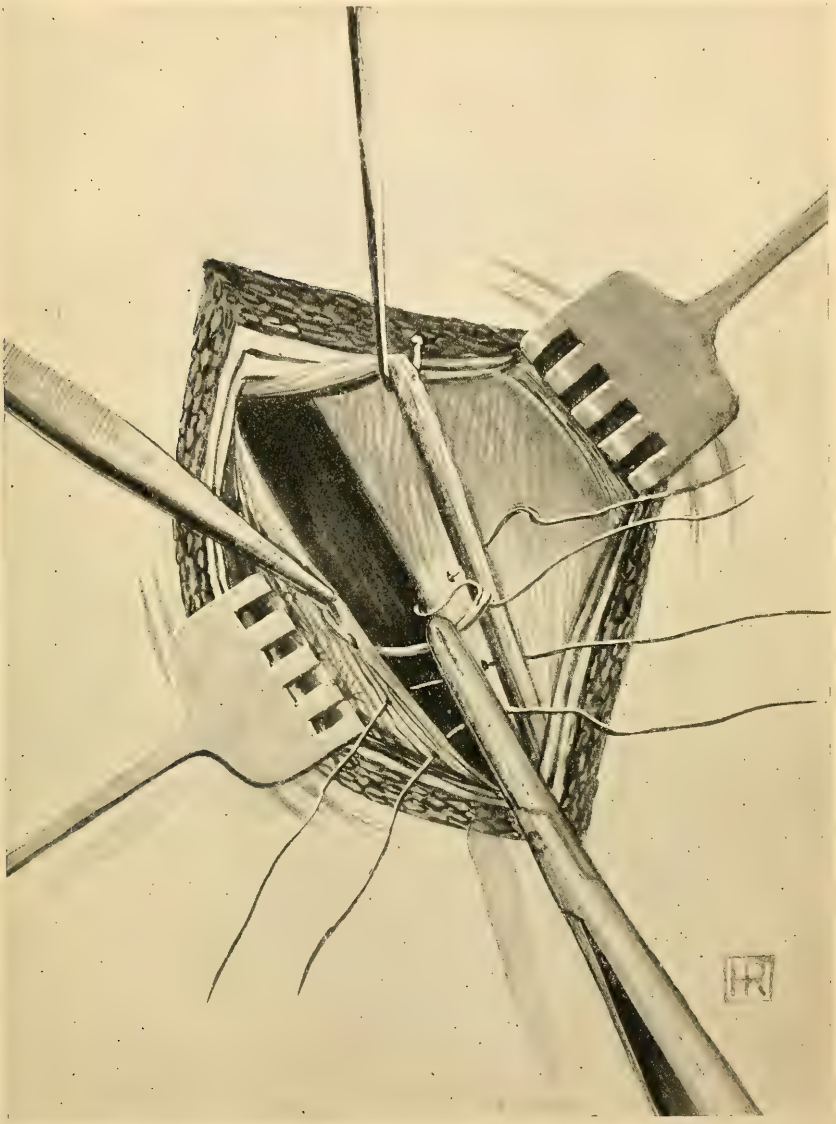


The ligated neck of the sac has retracted. The edge of Poupart's ligament is held back by the sharp retractor, exposing its under surface. The finger is feeling for the external iliac artery. The other sharp retractor holds the skin and aponeurosis, exposing muscle and conjoined tendon. (Lilienthal.)

interrupted silk sutures to Poupart's ligament, which is put under tension by pulling on the lower portion of the aponeurosis of the external oblique. The sutures should start low down, close to the spine of the pubes, and if possible the periosteum of the bone should be included in the first stitch. The stitches should be all placed and then tied from below upward, and enough space left at the top to allow the cord suffi-

cient room. The sheath of the rectus abdominalis may also be included in the first stitch, provided this can be done without too much tension. No space should remain between Poupart's ligament and the lower

FIG. 234.

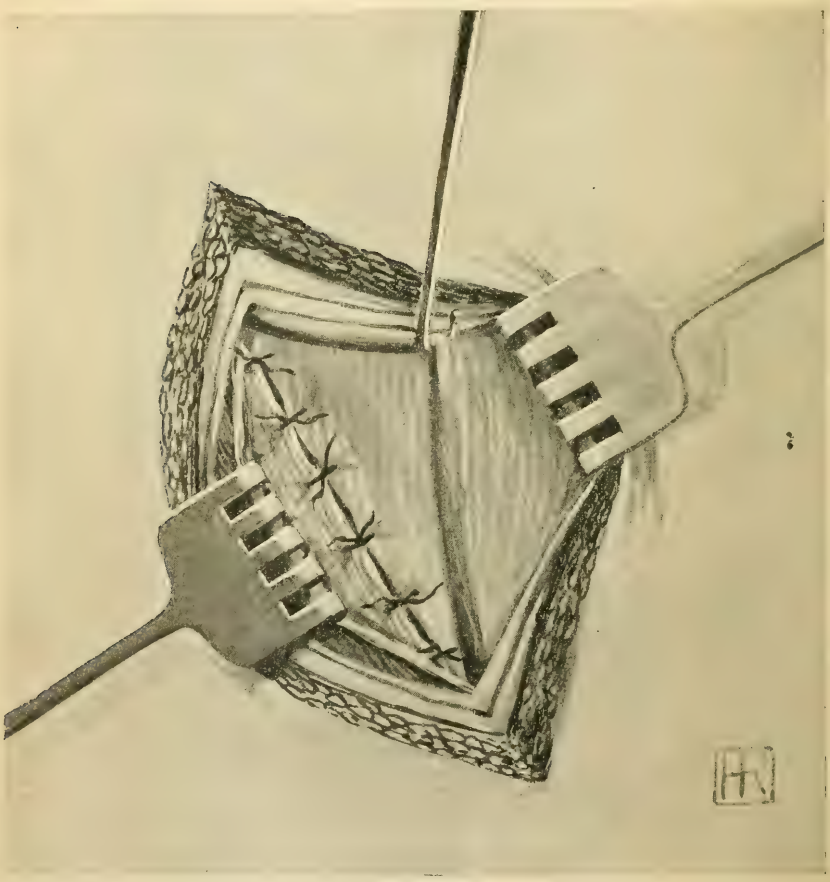


Passing the deep, important sutures through the conjoined tendon and the inner side of Poupart's ligament exposed by the retractor. The cord is held out of the way. (Lilienthal.)

margin of the muscle. This is frequently easy, but may be very difficult when the muscle is thin or deficient, or when the space to be cov-

ered is very broad. The cord is then put in place and the fasciæ of the external oblique sewn together with interrupted stitches. The skin-wound is then closed without drainage. The aponeurosis should be sewed very carefully. The edges should just touch, and not roll in or out, nor should the stitches be tied too tight, because this tissue is not freely supplied with blood and is liable to slough. Bassini's first report

Fig. 235.



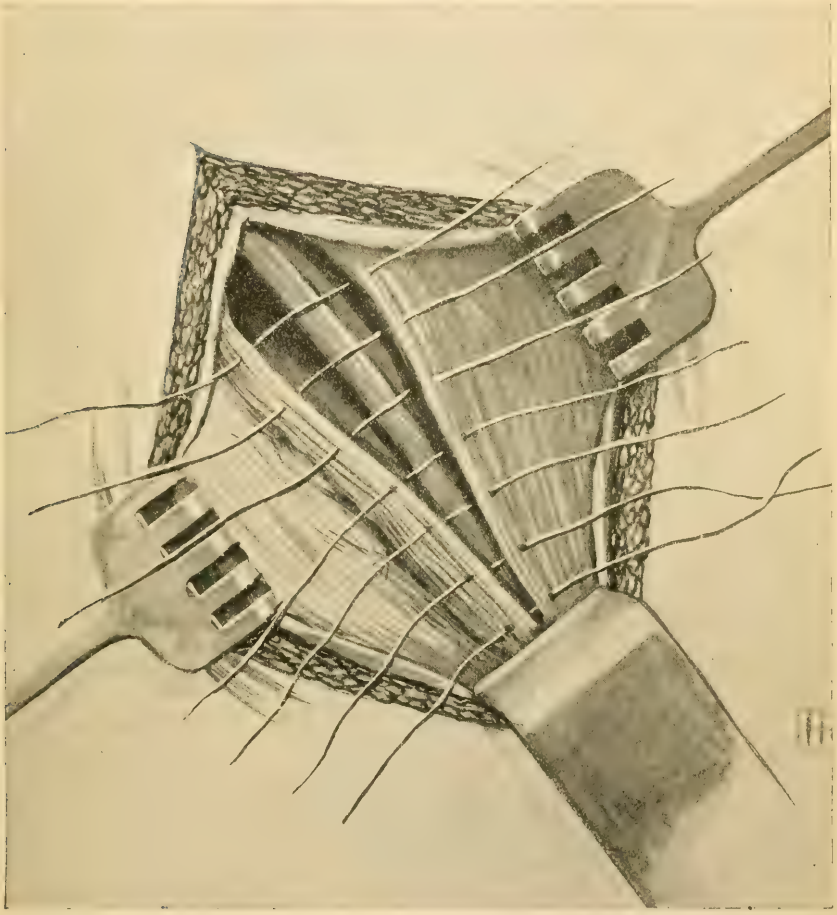
Deep sutures tied, forming new posterior wall for the inguinal canal. (Lilienthal.)

included 262 cases of inguinal hernia, 11 of which were strangulated. One of these died on the fifteenth day from pneumonia. The local condition had healed. There were 7 recurrences. The patients were not allowed to wear a truss.

Other similar methods have been recommended. In the course of time Wölfler passed the testicle through the space between the two recti muscles. Frank placed the cord in a bony canal chiselled out of the pubes. Ferrari, Magnai, and Postenski have also recommended meth-

ods of their own. Kocher's method shows good results and the technic is simple. The skin-incision is made parallel to Poupart's ligament about 1 cm. (0.4 inch) above this, and reaches to the outer third. The aponeurosis of the external oblique is exposed and the sac isolated up to its point of entrance into the abdominal cavity. It is completely

FIG. 236.



Cord lying on wall formed by deep sutures. Superficial sutures pass through the edge of the aponeurosis and the edge of Poupart's ligament. Note where the ligament is drawn in by the deep sutures. (Lilienthal.)

separated from the scrotum. An incision is made through the external oblique about 1 cm. (0.4 inch) beyond the internal ring and in the direction of the muscular fibres. A pair of curved forceps are passed in through this opening down the inguinal canal, guided by a finger, and in front of the cord. The tip of the free hernial sac is grasped and pulled back out through the small opening above. The neck of the

sac is sewed into the incision with silk sutures, and the sac itself is removed. The canal is closed by passing silk sutures through the aponeurosis of the external oblique, internal oblique, and transversalis, and sewing these structures down to Poupart's ligament. The cord must be protected with a finger or spatula and pulled down and kept under tension. The canal is closed until there is just room enough left for the cord. The method is simple and has the advantage that the external oblique is not split.

Kocher has recently described an invagination method, which is similar to the above up to the point where the hernial sac is isolated. The tip of the sac is then grasped with a pair of forceps and invaginated through the canal, and the forceps with the invaginated sac pressed against the abdominal wall outside and above the internal abdominal ring. An incision is made through the abdominal wall to the forceps and the sac with the parietal peritoneum is pulled out through the opening. The parietal peritoneum is then slit and held in place with clamps. The sac is put under considerable tension, crushed at the base, transfixed, and tied off. After removing the sac and replacing the stump the opening in the aponeurosis of the external oblique is closed with the same stitch. The canal is closed in the same way as already described. The average stay of the patients in bed is ten days.

Girard's method is especially adapted to large hernias with lax abdominal walls. The skin and aponeurosis of the external oblique are divided just as in Bassini's operation, except that care is taken to leave a strip of aponeurosis of about the width of a finger along Poupart's ligament. After treating the sac in the usual way the internal oblique and transversalis are sewed to the under surface of Poupart's ligament with a continuous stitch. The upper portion of the external oblique aponeurosis is also sewed to the deep portion of Poupart's ligament, and the lower portion is sewed to the external surface of the upper portion about 1.5 cm. (0.6 inch) from the margin, so that the aponeurosis is doubled for a certain distance. A small space is left below to allow for the cord, while the skin is closed by a continuous stitch.

Schede has recommended the use of buried silver wire for the purpose of closing the inguinal ring. Witzel made use of wire netting that healed in place sometimes in spite of suppuration. Götel recommends a similar method, and Trendelenburg and Kraske made a flap of bone and periosteum from the pubes, which was turned upward.

The accidents that may happen during a radical operation are: injury of the bladder, which may be fatal if not recognized early; or the spermatic cord and the vas deferens may be torn, an accident that may be followed by atrophy or gangrene of the testicle. Extensive resection of the omentum is frequently followed by hemorrhage if the ligatures are not applied with great care. In individual cases it has also been followed by more or less fixation of the intestine associated with symptoms of obstruction, due to strangulation beneath bands or

due to torsion or new adhesions. These accidents are not common, but should be recognized early and treated with timely laparotomy. If the bleeding in the wound is not accurately stopped, there is liable to be suppuration which is usually superficial, but even when deep, peritonitis is not liable to occur. Suppuration interferes greatly with the chances of a permanent cure. It is very annoying to have silk thrown off long after the operation, although individual accidents of this sort should not lead one to be satisfied with catgut, because this is absorbed too rapidly. Opinions differ, however, on this point. The severest complications are the small foci of bronchial pneumonia that develop insidiously and announce themselves only as a certain increase of respiration with a sense of oppression. This condition is especially to be feared in old people with bronchial catarrh, also in individuals with emphysema, in patients with heart disease, and in alcoholics. The prognosis, of course, differs considerably with the age of the patient, with small and large hernias, with old and recent ruptures, in strong and feeble individuals, and when the hernia is single or multiple. At the present day the consensus of opinion seems to be that no appliance should be worn after an operation that has been successful in every way and where the prognosis is favorable. When the hernia has been very large, and there has been at the start some probability that it might recur, it may be advisable to wear a smooth spica bandage for a certain length of time. The patients should be examined within a few months after operation, and if there is any tendency to recurrenee the condition should be held within bounds as much as possible by a bandage. The mortality in the last ten years has sunk to about one-tenth of what it formerly was. The results, of course, are better with surgeons who operate chiefly on young and healthy individuals. Up to twenty years ago the mortality was about 25 per cent.; ten years ago it was 5 per cent. At the present time the death-rate varies in the hands of different authors between 1 death in 700 operations up to 1 per cent. The results in young children are very favorable. Broca performed 450 operations on children under fifteen years of age, with 1 death. Fränkel reports 16 operations on infants.

At the present time only about 10 per cent. of the cases show recurrence, although the figures are not so reliable as the statistics on mortality, because the patients themselves were not examined and personal statements or communications by letter were taken as evidence. The majority of recurrences appear within the first six months after operation, especially if the patients resume their former occupation. Bassini's communication in 1890 included 462 operations with 3 per cent. of recurrences; 77 of the patients operated on in Albert's clinic showed 2.7 per cent. of recurrences; Championnière operated on 650 patients, with 21 recurrences; Berger operated upon 350 cases, with 10 recurrences; Rotter operated upon 122 cases, and had 1.5 per cent. of recurrences. Similar results are reported by other authors.

CHAPTER XXI.

COMPLICATIONS OF HERNIA.

All patients with hernia have certain symptoms in common. Besides these there are certain complications that may arise in particular cases. The most important is strangulation; next to this is fecal impaction in the portion of the intestine included in the hernia; and, finally, inflammation of the hernia. These conditions cannot always be sharply differentiated, although they will be described here separately for therapeutic reasons. Any strangulation is associated with obstruction to the passage of feces and later with inflammation. There are, however, cases of fecal impaction and inflammation that need not be associated with strangulation.

IMPACTION OF FECES WITHIN THE LOOP OF INTESTINE INCLUDED IN THE HERNIA.

The loop of intestine within the hernia becomes gradually distended with formed fecal matter and may eventually become completely obstructed. The author has already mentioned that there is considerable difficulty for the passage of feces in the loop of intestine included in a rupture, especially when the hernia has existed for a considerable time in old individuals and is very large and irreducible. The chief cause is paralysis of peristalsis. The muscular coat, which is overtaxed and hypertrophied, degenerates and refuses to perform its usual duties when large quantities of indigestible food are consumed, or when there is some disturbance of digestion.

Symptoms.—These patients are usually accustomed to a certain amount of disturbance, and are apt to overlook the early stages. When the tension in the hernia becomes great, they are likely to become anxious, although the general condition is not much disturbed except for loss of appetite and a certain amount of palpitation. As a rule there is no fever. The hernia is not reddened and is not necessarily tender to touch. It is especially noticeable that there is no increased sensitiveness in the hernial ring. The abdomen becomes gradually distended: there are colic, nausea, and vomiting. The vomiting depends largely upon the taking of food and is only occasional. It is not the same as the vomiting of acute obstruction. The onset is gradual and the course chronic. The patients do not take much food, feel extremely uncomfortable, and emaciate. They become progressively weaker and die in the course of a few weeks without

there having been any especially acute disturbance. If the vomiting persists for some time, it may be more or less fecal in character. The autopsy does not show disturbances in circulation or inflammatory changes in these cases, although the intestine is stuffed full. Rose has repeatedly called attention to this condition.

Diagnosis.—The diagnosis is based chiefly upon the history. The hernial contents may sometimes be felt as formed, more or less resistant masses of feces. There is also absence of acute symptoms of strangulation.

Treatment.—The treatment is that of fecal obstruction in general. The chances of improving the condition are better if it is possible to push the distended portion of the intestine back into the abdomen, because the conditions for removing the contents of the bowel are then much more favorable. An attempt of this sort should be made under a general anæsthetic. Massage tends to immobilize the fecal masses and crush the impacted contents of the gut. If these measures do not give the desired results, continuous pressure may be applied with sandbags or injections may be given of several quarts of lukewarm or cold water. Oil injections seem to be most effective, but do not act for a considerable time after being given. Should these efforts remain fruitless, irritating substances may be injected into the large intestine, such as concentrated salt solution or pure glycerin, which may stimulate the muscular contractions of the intestine. Cathartics are usually useless, and the more irritating drugs should be especially avoided. Castor oil may be given if it is deemed wise to give any cathartic. If there is the slightest suspicion of strangulation, one should avoid cathartics absolutely and administer opium even in large doses. After several days there may be a very surprising movement of the bowels as the result of this treatment. Washing out the stomach should be tried, especially when there is vomiting. Sometimes it is possible to remove a considerable quantity of intestinal stomach contents through the stomach-tube, and this diminution in the intra-abdominal pressure has a distinctly beneficial influence. It is astonishing how long the condition of these patients remains fair, even when they take very slight quantities of food. One should, therefore, never despair of relieving the condition. The prognosis of operations performed for this condition is bad, although in certain cases where there are symptoms of strangulation nothing else remains to be done. Fecal impaction of this sort is usually observed in old people, although it does occur in large hernias of children. Goyrand reports the case of a child six months old in whom the sigmoid flexure contained in the hernial sac was filled with fecal masses that could be pushed along after enlarging the hernial ring. This child died in spite of the large movements. Certain authors advocate morphine instead of opium, and of late years atropine has been recommended. The diagnosis of many of these cases is not certain, and in all probability the results are no better than when opium is used. Symptoms of poisoning may occur after using atropine.

INFLAMMATION OF HERNIA.

There are sometimes found in hernias secondary conditions indicating some previous inflammation without the patient ever having had any severe symptoms, with anatomical conditions that make it highly improbable that the hernia has ever been strangulated. These conditions are also found at autopsy and at operation. The hernial sac and contents are usually covered with peritoneum, so that any inflammation in this region will show the characteristics of localized peritonitis.

Slight cases may be secondary to some mechanical irritation, such as pressure from a truss, or some slight contusion, or forcible attempts at reduction in a hernia that is reducible although only with difficulty. Other cases are secondary to inflammation of the hernial contents, especially of the loop of intestine. Enteritis may be associated with ulcers, for instance, in typhoid and tuberculosis; and the inflammation following ulcerative appendicitis is also of importance in this connection. The appendix is found in the hernia alone or with other abdominal viscera, such as the cæcum, small intestine, and the omentum. This structure is liable to become infected, perforate, and produce a peritonitis which is walled off by adhesion from the general peritoneal cavity. Sometimes, however, the inflammation may extend to the general peritoneal cavity just as in the ordinary cases of appendicitis. The condition has frequently been confounded with a simple abscess, and the true nature was not recognized until a fecal fistula developed. If marked inflammation develops in a small rupture with considerable distention of the sac, high temperature and signs of strangulation without cessation of the movements or passage of gas, one might suspect appendicitis in a hernial sac. In an ordinary strangulated hernia the symptoms of inflammation appear later, while characteristic symptoms of obstruction have existed for some time. Several cases of tuberculosis of the hernial sac have been reported in Bruns', Socin's, and Helferich's clinics. The inner surface of the sac is covered with numerous tubercles (Fig. 232), and there is considerable cloudy fluid. Usually the condition was simply part of a general peritoneal tuberculosis. Sometimes the inflammation has extended to the sac from puerperal inflammation of the connective tissue in the pelvis, or from some suppuration in the vicinity of the hernia. These inflammations may produce a serous effusion, or a fibrous deposit, or pus. The micro-organisms may enter from the pelvic inflammation or from ulcers in the intestines. There are, however, cases in which it is more difficult to explain the method of infection; for instance, when suppuration takes place in a sac that contains only strangulated omentum, or when suppuration occurs in a sac that no longer communicates with the peritoneal cavity. It is to be presumed that at some prior date there was intestine as well as omentum in the sac, and that the pus-producing organisms escaped from the bowel, which had been reduced or slipped back itself while the inflammatory process in the sac continued to develop. In other

cases the inflammation seems to be metastatic; pus organisms deposited from the blood-current find conditions favorable for their further development.

Symptoms.—The symptoms may be slight; and patients with large irreducible hernias are too much accustomed to slight upsets to pay much attention to the signs. The more severe types, especially the suppurative variety, always present a pronounced clinical picture. The hernia becomes larger, tense, and painful. The overlying tissues become œdematous and hot. There are general symptoms, such as vomiting, colic, and sometimes collapse. It is important to remember that the pain in these cases spreads over the entire hernia, and is not localized to the neck of the hernia, as in cases of strangulation. It is also of importance that there is no complete stoppage of the bowels. There may be diarrhœa or very small movements with considerable gas. In inflammations with adhesions, observed especially when the omentum is down, palpation elicits a distinct sense of crepitation which is due to the tearing of slight adhesions. Sometimes the symptoms develop in such a way that they resemble those of an acute abscess tending to rupture externally.

Treatment.—In the slight cases without general symptoms rest in bed, ice, and attention to the bowels will be sufficient. When there are severe symptoms indicating suppuration one should not wait long before opening the sac, especially as in many cases it is uncertain whether or not the local condition is due to strangulation; and if there is the slightest doubt in this direction, an operation is always indicated, for reduction by taxis is absolutely counterindicated.

STRANGULATED HERNIA.

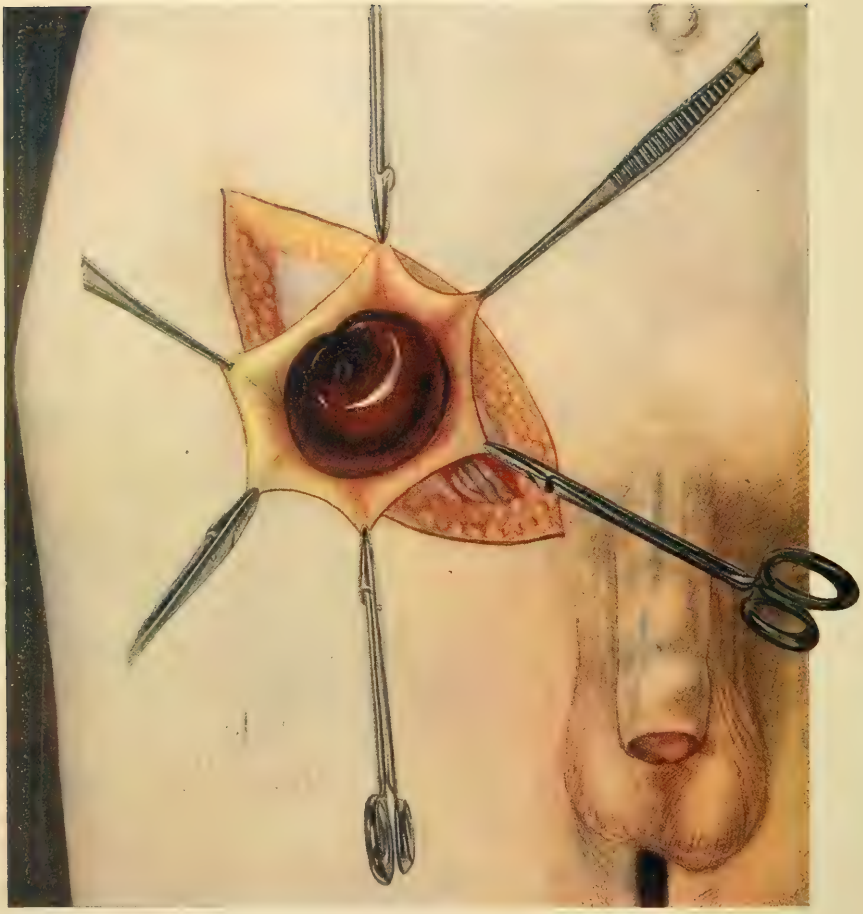
A strangulation is due to a constriction about the hernial contents that renders the rupture irreducible, interferes with the circulation of the hernial contents, and when lasting for any length of time is followed by gangrene. An elastic constriction or strangulation and fecal impaction or incarceration are distinguished.

A loop of intestine in the vicinity of the opening to the hernia becomes crowded down into the sac. When the increased amount of pressure diminishes, the hernial ring, which has been forcibly distended, contracts again and grasps the loop of intestine. The same mechanism applies when a large piece of intestine is crowded into a hernia that already contained considerable gut. The jammed-in piece of intestine cannot liberate itself, and when held down by a very firm ring taxis is of no avail. The only help to be had is by splitting up the ring. This elastic constriction of the intestine not only fastens the loop in place, but also produces stoppage of the bowels and interferes with the circulation. In slight cases there is venous congestion; but when the constriction is firmer there may be complete cessation of circulation, because the arterial supply is also cut off. The intestine

in these cases may be absolutely empty, for the contents may have been stripped back while the loop was being crowded down.

Fecal impaction is aided by the fluid or gaseous contents of the intestine. A considerable quantity of fluid or gas is suddenly crowded down into the loop of intestine contained in the hernia. When the pressure diminishes, the otherwise movable loop is fixed and the contents cannot be displaced. The hernial ring may be so large that one cannot speak of elastic constriction proper. At the neck of the sac there are some diminution in the lumen of the intestine and a certain lack of proportion between the ring and the hernial contents. Later this malproportion is followed by constriction. The constricting bands may be in the sac itself or the immediately surrounding tissues, but usually there is one special constricting band, although there may be several points in one and the same hernia. If the intestine is constricted in one place, so that the lumen of the gut is about 1 cm. (0.4 inch) across, liquid contents may be squeezed out under slight pressure. If, however, considerable pressure is used, the lumen becomes closed and not a drop can pass. This same effect is produced, as shown by Kocher, by gradual distention of the intestine above the point of constriction, so that the chief point is not the fact that the intestinal loop is filled with material, but that the intestine above is distended; and when this portion is filled with air the distended part exerts a certain amount of traction on that not distended. This in hernia is followed by a sliding downward of the mucous membrane of the portion of gut that is not held fast in the loop contained in the hernia, while the serosa remains fixed. Kinking of the intestine is also of considerable importance, and is more marked the greater the amount of traction exerted upon the intestine above by the portion held in the hernial sac. The mesentery also comes down with the intestine and crowds itself in between the two portions of the gut, so that the intestine is flattened against the side of the ring. In certain cases the constriction is due to rotation of the loop at a moment when it is considerably distended. (Scarpa, Roubaix.) When the constriction is elastic, it may be so firm that all the circulation is cut off immediately, resulting in complete anæmia, although in some cases only the veins are interfered with. Even when there is disturbance of the circulation at first, it is liable to develop secondarily to distention of the intestine with fluid or gas, as shown by Kocher. The congestion is associated with secretion of mucus, hemorrhages into the intestinal wall, and paralysis of the gut. It happens in this way that in cases in which the hernial opening is sufficiently large to allow the intestine to pass without constriction that the congested and thickened loop of bowel no longer has sufficient room in the ring and becomes secondarily constricted. The result of strangulation is finally gangrene. The severity of the disturbance, the rapidity of development, and the secondary symptoms vary, so that no uniform picture prevails. It is astonishing in how short a time the intestine may become gangrenous. The intestinal vessels have few anastomoses, and besides this the fecal

PLATE XV.



Strangulated Right Inguinal Hernia. The Sac has been opened and its edges are drawn apart by means of forceps. The Inguinal Canal and Spermatic Cord have been dissected. (Park.)

contents of the loop are very apt to decompose rapidly. The intestinal wall with its disturbed circulation is no longer able to resist the bacteria contained in the loop and gangrene rapidly supervenes.

The fluid accumulating in the hernial sac is called the hernial fluid, and is generally proportional to the duration of the strangulation and the size of the secreting area. In large inguinal hernias there is usually more, although there is a little disturbance of circulation where the secretion is most marked. When the circulation is completely interfered with, there is, of course, no fluid at all. This fluid is at first clear, amber yellow, serous, but soon becomes reddish, due to blood-pigment and blood, and may contain fibrin deposits or small coagula. The fluid may still remain clear under these conditions. It gradually becomes cloudy, due to the increasing number of white blood-corpuscles, and when persisting for a considerable length of time has a foul odor. If the intestine has become gangrenous, the entire sac may be filled with decomposing feces and gas. If the strangulation has lasted for more than twenty-four hours, bacteria are almost always found in the fluid. It would seem, however, as if the fluid had a certain bactericidal action, because the micro-organisms are not very numerous and seem to have diminished vitality. Cocci are usually found first, and later bacilli. There must have been some damage to the epithelium of the intestine which allows the bacteria to advance through the different layers, which is very apt to be the case if there are many small hemorrhages.

If the circulatory disturbance is relieved early, the intestine may recover. On the other hand, if it has existed for a considerable length of time, a loop of intestine that seems perfectly normal on inspection may later become gangrenous even after the constriction is removed. The gangrene usually commences in the mucous membrane. The layers of the intestine are first infiltrated with blood, in which the micro-organisms develop rapidly. Multiple purulent foci appear and extend toward the serosa. This finally loses its glistening appearance, becomes covered with fibrin, is more or less discolored, and the intestine becomes lax and friable, so that even the slightest amount of traction may produce a tear.

It is extremely uncommon to have extensive gangrene from the first. There are usually small areas that finally become confluent. The disturbances of nutrition appear first in places where the circulation is poorest—*i. e.*, along the convex border just opposite the attachment of the mesentery. The portion subjected to the constricting ring is frequently damaged most, and shows a marked indentation as if a string had been tied around. The gangrene in this place resembles that due to pressure, for it extends from without inward. Even before gangrene is at all evident macroscopically, micro-organisms may have infiltrated the layers of intestine, reached the serosa, and found their way into the peritoneal cavity, where they produce secondary peritonitis. There may also be considerable disturbance in the portion of the intestine leading to the strangulated loop. Above the hernia

there will be occlusion of the bowel and the contents are increased by active secretion from the mucous gland. This stagnant material rapidly undergoes putrefactive changes and the intestine becomes quickly distended with gas. This distention interferes with the circulation and the distended portion of the gut rapidly succumbs to a progressing ulcerative process which Kocher has called "stretching" ulcers. These ulcers may perforate and produce fatal peritonitis even when the strangulated intestine itself has been successfully relieved.

Here will be described an average case of strangulation. As a rule the patients mention some incidental cause, such as overexertion or some awkward motion or straining during stool. Sometimes they have partaken of a too hearty meal, or there is some digestive disturbance. The moment that strangulation takes place there will be an increase in the size of the hernia and marked pain that as a rule extends over the entire abdomen, but which becomes localized within a short time in the region of the hernia. Within a comparatively short time the individual has a movement of the bowels associated with more or less tenesmus. He may pass a certain amount of solid or liquid fecal matter, but does not get the desired relief. There is a distinct sense of obstruction felt as if at a certain point the intestinal contents and the gases could not be pushed out. The patient endeavors again and again to relieve himself by going to the closet; without success, however, even with the aid of injections or cathartics. At the very onset of the pain there is liable to be nausea and vomiting, which may at first be more or less connected with taking food or liquids, although the gagging and vomiting may not cease even when the stomach is perfectly empty. The hernial swelling becomes larger and harder and sensitive to pressure. The intestinal contraction becomes more marked and is associated with colic and borborygmus. The vomiting, which at first consisted of stomach contents, becomes more abundant and is mixed with bile. After the vomitus has had a distinctly offensive odor for some time a considerable amount of dirty greenish-brown material, resembling a decomposed loose movement of the bowels, is suddenly voided by mouth, frequently without any vomiting effort or gagging, just as if the stomach and intestines had overflowed.

In certain cases the general condition may be comparatively good, although the vast majority of the patients are very sick, restless, and anxious, and refuse all food because of the fear of vomiting. The pulse becomes small and increases in rate, the respiration becomes superficial, the extremities become cool, the tip of the nose looks pointed, the mucous membranes and ears are cyanotic. The patient is covered with cold perspiration and the temperature is subnormal. Many patients collapse in this stage with noticeable subjective euphoria without there having been any other complications.

In other cases peritonitis develops. The abdomen becomes distended, the skin is dry and hot, the face is reddened, and the temperature may rise, although not necessarily. Symptoms of peritonitis may

appear suddenly after perforation, or develop gradually, and the onset may be associated with quite noticeable subjective improvement. This does not last long, however, for the patients soon become weak, the pulse thready, and the facies pale and pinched, with a fatal result within a short time. In the meantime the hernia has undergone certain secondary changes. It is harder, the overlying skin is reddened and œdematous and is tender to touch. The œdema extends to the surrounding regions, and sooner or later one region bulges and shows distinct fluctuation. The skin becomes discolored here and ruptures. Decomposing pus and foul fecal matter are frequently passed in large quantities through the opening. This rupture may take place without involvement of the general peritoneal cavity, because adhesions may have formed between the intestine and the wall of the sac before the loop of gut became gangrenous. The peritoneal cavity is completely walled off in this way. When rupture does occur, it takes place first into the sac, an event that is followed by violent suppuration and inflammation that extends to the overlying tissues, which rapidly disintegrate. There are cases in which rupture of this sort takes place in a very short time and along the shortest route, so that the patients are suddenly relieved of all the annoying symptoms. This is, however, exceptional. Fecal abscesses of this sort usually undermine the different layers of tissue, form pockets, and involve the tissues diffusely before they reach the surface. In these cases it may take considerable time before all the individual pockets empty themselves, and the skin may be destroyed as far down as the middle of the thigh and over the lower half of the abdomen. Even when the peritoneum is not involved, therefore, these fecal abscesses are a source of much danger to the patient, and 95 per cent. of the strangulated intestinal cases left to themselves die. The causes of death are: (*a*) immediate shock, due to the effect of strangulation upon the nervous system; (*b*) collapse later, associated with symptoms of intoxication; (*c*) peritonitis with or without rupture of the gangrenous intestine; (*d*) severe fecal suppuration; (*e*) complications, such as pneumonia, etc., and some die of inanition even after an artificial anus is formed.

Symptoms.—An accurate history is very important, but the patients are very likely to make false statements or give a very indifferent description. Many patients do not know what a rupture is, or whether they have had one for a long time. They cannot state whether the hernia ever went back, or whether it is larger or smaller than it was formerly. Dread of an operation leads the individual to belittle his symptoms, or to claim that he feels considerably better during the last few hours. It is very important to find out what the first symptoms were: whether there was a change in the size of the hernia, and whether there was immediate pain, nausea, or vomiting. A strangulated hernia is irreducible. It becomes larger and harder, and after a certain time is sensitive to pressure. The increase in size and tension is the result of an increase in the contents of the sac.

The tension of the sac is increased by the additional intestine, the increased amount of fecal contents, and by the fluid accumulating in the intestine and outside in the sac. If the hernia was irreducible beforehand, the fact that when it becomes strangulated coughing and straining do not influence the tension is an important diagnostic point. If the intestine becomes gangrenous, the clinical picture will be that of fecal suppuration.

When the obstruction is complete, no fecal matter or gas will be passed. In the early stages the lower intestine may be emptied, although without relief to the patient. In rare cases when a loop of small intestine from the upper part of the gut has become strangulated, there may be a profuse loose movement due to the increased transudation into the lumen of the gut and increased peristalsis (cholera herniare, Malgaigne). When only a section of the wall of the gut has become strangulated, there may be sufficient lumen left to allow the passage of fecal matter and gas.

Meteorismus above the strangulated loop is a further result of obstruction. The condition is not necessarily the result of occlusion, and develops only when the absorption of gas from the intestine takes place less rapidly than it is formed. There are cases in which the gut above is not distended, although the lumen below is completely occluded. It is, however, always present when the circulation of the intestine is interfered with, and is found almost constantly in the strangulated loop itself. The intestine here may be under such pressure that the condition is not noticed, but on opening the hernia it will become evident under how great tension the intestine has been, for the strangulated loop may suddenly distend enormously. This type of distention has been called by Wahl and Kader "local meteorismus." Besides this local variety, there is a type due to congestion with secondary paralysis of the muscles of the intestine, followed by accumulation of gas, because of the rapid decomposition of the fecal contents and intestinal secretion.

Vomiting is a further result of obstruction, and will become fecal sooner the higher up the strangulated loop of the intestine. When the strangulated loop belongs to a portion of the gut lower down, this symptom may be absent. The vomitus consists of decomposed fecal contents, which is voided in large quantities long after the patients have ceased to take food. It is in all probability largely composed of increased secretion of the irritated intestinal mucous membrane. Besides this fecal vomiting there is another variety which is due purely to some nervous influence. The poisonous products of decomposition become absorbed and are a distinct additional danger. The more sudden the strangulation develops and the more pronounced the symptoms due to bruising the intestine—*i. e.*, symptoms that appear when the intestine is injured in a similar way, such as a blow upon the abdomen or with peritonitis or torsion of the testicle or ovary. These symptoms, due to the effect upon the nervous system, are grouped together in the term "strangulation shock." By this is

meant considerable disturbance of the general condition, nausea, continued vomiting, small pulse, pallor of the skin and mucous membranes, and cold perspiration. Vomiting in these cases bears no relation to the kind or quantity of the intestinal contents. The effort to vomit is a reflex matter, and it is characteristic that this variety commences immediately after strangulation has taken place; therefore at a time long before the intestinal contents can have become stagnated. The physiological explanation of strangulation shock is given in Goltz's well-known experiment. This variety of disturbance is especially characteristic of the severer types of elastic constriction that interfere most with the nutrition of the intestine. The pain, which is also due to irritation of the nerves, is sometimes very violent, although certain patients are perfectly indolent, and it is by no means justifiable to conclude that the strangulation is of moderate degree just because this symptom is absent. There are certain complications that need not necessarily take place, but which may become of great importance. Peritonitis may be due to perforation or may develop gradually because of bacterial infection. Perforation is characterized by sudden violent pain spreading over the entire abdomen, which becomes uniformly distended so that the liver and splenic dulness is completely covered up. The pulse is small and rapid, respiration is increased, the extremities are cool, and the facies is the so-called facies Hippocratica. When peritonitis develops slowly, there will always be a slight rise of temperature. The abdomen becomes tense, due to reflex action, and is also distended. There will be complete cessation of intestinal peristalsis. Pneumonia is a further complication. There will be small lobular foci of inflammation, due partly to emboli from thrombosed mesenteric veins and partly to metastases of the peritoneal sepsis. Oliguria, and even anuria, are the results of the diminished amount of water contained in the body, a condition which is frequently associated with albuminuria because of the damage to the kidney epithelium.

Diagnosis.—The diagnosis is easy when the history shows that there has been a previously movable hernia which has suddenly become immovable, combined with the appearance of the above acute symptoms. When these symptoms are absent, the difficulties may be great indeed, and even the most experienced surgeons may err. The gravest error is to assume that there is no strangulation when such is really present and remains inactive. The error of operating without finding strangulation is less to be feared, because, provided the technic is good, the patient is very liable to profit. In cases in which there is doubt about the diagnosis one should always proceed as if a strangulation existed; and if one does not adhere to this hard-and-fast rule, he will sooner or later meet with disaster. The examination should be methodical and thorough, and one should never overlook the fact that several ruptures may be present at the same time. Many cases have been reported in which an irreducible but not strangulated hernia was operated upon, and on autopsy a strangulation was found elsewhere.

Even the region where it is unusual to have a hernia should be carefully investigated. The strangulated hernia cannot be reduced, so that the most important thing is to show that the mass extends into the abdominal cavity. The peduncle may allow a certain amount of lateral motion, but motion upward and downward will be extremely limited. When the hernia is deep seated, so that there is no mass to be felt, increased resistance and localized pain are of importance, as will be considered in connection with Obturator Hernias.

The results of percussion are not reliable. The strangulated intestine is frequently emptied or contains no gas, or the gas is not noticed on account of the large amount of hernia water. A tympanitic note may be also produced by the gases of decomposition when the intestine has become perforated and when there is fecal suppuration. In these cases, however, there will be as a rule emphysematous crackling on percussion.

The general symptoms are the safest guide to the severity of the condition. Violent vomiting at the onset, collapse, etc., are of more importance than the local findings, especially as in the severe elastic constrictions that shut off the arteries the hernia itself may not be under any great tension. Later will be considered the absence of marked symptoms in severe cases of strangulation of the lateral wall of the intestine. The more insignificant the hernia appears, the more careful should be the examination. One should never be satisfied with probabilities, but should determine the conditions present definitely.

There is no doubt that strangulation of a small omental hernia may also produce severe symptoms: vomiting, fecal obstruction, colic; although the tumor is not under so great tension and the tenderness in the region of the neck is not so marked as in cases in which the intestine is involved. The tumor feels solid, there is less disturbance of the general condition, and if there is fecal obstruction there is as a rule passage of gas. For this reason, one should never consider that the condition is one of strangulated omentum unless the symptoms are slight. Besides, with a hernia that is evident on inspection and is irreducible, there may be an internal strangulation in the region of the hernial ring or at some other place in the abdominal cavity.

There is at times marked similarity between a strangulated hernia and strangulation due to intestinal obstruction elsewhere. The author does not approve of administering opium and washing out the stomach in cases in which the diagnosis is difficult, because this may improve the symptoms for a time to be sure, but does not improve the strangulation. The subjective conditions improve, but this is only too often apt to be followed by a sudden fatal result which shows the error in judgment and the treacherous nature of this method of treatment.

There is considerable difference of opinion as to whether a portion of the wall of the intestine can become strangulated or not. Those authors that deny the possibility of this condition claim that the intestinal tube bulged in the affected region beforehand, and that this bulging increased because of the strangulation, or that the strangulated

portion of the wall was held firmly to the hernial sac by adhesions. These hernias are almost always small and have narrow rigid openings. They are found chiefly in the femoral region or in the obturator region, rarely in the inguinal region. Generally, there is no history of previous hernia. During some exertion, such as straining or lifting, or coughing, a small swelling appears that produces marked symptoms. If only a small portion of the gut is caught, there may be sufficient lumen left to allow the fecal contents to pass, so that there are no symptoms of complete intestinal obstruction. The damage done to the nutrition of the intestinal wall, however, may be considerable, and gangrene develops rapidly. As a rule the intestine is the only structure contained in the sac, although occasionally a piece of omentum is found. On operation a bulging of the lateral wall of the intestine may be discovered which resembles a diverticulum. The wall of this area is thickened and firm, which is rather suggestive of the condition having existed as a diverticulum for some time previous to strangulation. It may be that the lateral bulging of the wall has existed for some time, but there is no doubt that in certain cases the condition develops at the same time that the symptoms of strangulation appear. Trzebicky reports a case in which a circumscribed diverticulum disappeared within fifteen minutes after the strangulation had been reduced. It can therefore have existed for only a short time, although it is difficult to realize how this condition developed. The constriction of the wall of the gut is followed by transudation and serous infiltration of the neighboring portion of the intestine, which still further fixes the gut in place. This swelling may diminish the size of the lumen of the portion of the gut not involved, and there may be secondary obstruction to the passage of feces. It is well known that in these ruptures that are so liable to become gangrenous that the symptoms of intestinal obstruction are not apt to be well defined, and that the danger is not recognized. The severity of the onset and the initial strangulation shock is of especial importance in these cases.

Strangulated Omentum.—The mechanism is the same as that considered in connection with the intestine. The piece of omentum that becomes caught swells on account of the disturbed circulation, and thrombosis or gangrene with inflammation in the sac is apt to develop. The symptoms do not appear so rapidly as those in connection with the intestine, because the vessels are more or less protected by the fat and there are no intestinal bacteria to be dealt with.

The symptoms are not so marked, although there is almost always intense pain at the onset, not only in the hernia itself, but in the abdomen, especially in the epigastric region. The hernial swelling becomes larger, firmer, sensitive to pressure, and is dull on percussion. On palpation it may be possible to detect the dense nodes of omentum until the amount of hernia water makes this impossible. Vomiting is not uncommon at first, but the movements of the bowels and the passage of gas are not interfered with. The general condition remains

fair, and in some cases the appetite may not be interfered with. The condition may last for several days, and recovery may take place spontaneously. The symptoms subside gradually. The omentum, however, is irreducible and rolled up into a ball. After a while it will be possible again to distinguish certain lobes and strands on palpation.

Gangrene is uncommon, and when present there is usually suppuration in the hernial sac or between the individual parts of the omentum. The sac becomes ruptured and the pus reaches the surface. After incision or after spontaneous rupture, gangrenous tabs of omentum are thrown off and the abscess cavity gradually closes. Cases have been reported in which the suppuration extended to the abdominal cavity, although this is an uncommon accident. Certain cases of strangulated omentum present such severe symptoms that they are confounded with strangulation of the intestine. There may be complete obstruction to the passage of gas and fecal matter, collapse, and even fecal vomiting. In all probability a loop of intestine was strangulated in these cases besides the omentum, and slipped back of itself or during attempts at reduction, so that on operation nothing but strangulated omentum could be found. Attention is called again to strangulation shock due to irritation of the peritoneal nerves.

Clinical Varieties of Strangulated Hernia.—The character of the strangulating band, the severity of the condition, the length of time it has lasted, etc., all influence the clinical picture considerably. The above described conditions apply to an average case, although there are widely differing conditions between the most severe acute cases and the slight cases, so that it has seemed advisable for practical reasons to subdivide hernia into superacute, acute, subacute, and chronic. In the acute types that are due to elastic constriction as a rule, the general symptoms are the most marked. There will be from the onset shock, cold perspiration, pallor of the extremities, cyanosis of the face, anuria, weak pulse, and early facies Hippocratica, combined with frequent vomiting from the first. This severe general disturbance is as a rule combined with considerable damage to the strangulated gut itself. In a number of cases reported the intestine has become gangrenous within twenty-four hours. It is not uncommon for these patients to die from the first shock without there being any gangrene of the gut or any peritonitis. Certain of these acute cases present a clinical picture resembling cholera, as already mentioned. In other cases the nerve symptoms are most marked. There will be muscular spasms, convulsions, delirium, and attacks resembling uræmia.

There are, on the other hand, severe cases of strangulation that are especially dangerous to the gut itself, associated with only slight general symptoms—so slight that the general condition—a good pulse with almost complete absence of pain and vomiting—leads the surgeon to be disastrously deceived. These latent types of strangulation are noted especially with hernia of the intestinal wall, and are especially feared because the intestine becomes gangrenous within a short time in spite of the absence of alarming symptoms.

Chronic strangulation is noted especially in connection with large hernias with large openings. The symptoms appear gradually and are easily overlooked, especially if the hernia is irreducible. The loss of appetite, obstipation, slight colic, vomiting in connection with the taking of food, are the only symptoms that are noticeable for several days. Then suddenly the symptoms become worse. These types correspond to the clinical picture of obstruction with internal closure of the intestine.

Treatment.—The strangulation should be removed immediately. Time is very valuable, for there are strangulations that prove fatal within a short time, and one should never allow any time to pass just because of the dread of deciding so grave a question. There are two methods of reducing the strangulation: (1) bloodless reduction by taxis, and (2) herniotomy. All other aid is only of accessory importance.

Taxis.—The most important thing about this method is that it should not be fractured too energetically or for too great a length of time. Many operators object to taxis in any case of acute strangulation, for this is one of the methods which consumes valuable time and frequently does not benefit the patient. There are cases, however, in which taxis is justifiable, such as those in which the strangulation is evidently not dangerous; therefore in cases in which there was no acute onset, no severe symptoms due to intestinal crushing, and in which the general symptoms due to intestinal strangulation are very slight. Then again when the hernial ring is very large, especially if previous attacks of strangulation have been successfully overcome by taxis; and finally in the cases in which the operation is bound to be very difficult and dangerous; therefore in old people with large hernias, where not only the operation itself, but the long rest in bed is a source of danger. In young children taxis is justifiable because it is difficult to keep the field of operation clean and complications in the wound are not uncommon. Certain authors claim that it is justifiable to try taxis in those cases in which one reaches the patient immediately after the appearance of symptoms.

Taxis is absolutely counterindicated in cases in which small hernias give rise to severe symptoms, especially to pronounced strangulation shocks at first, and in cases of strangulation that have existed for some time and produced disturbances of nutrition in the intestinal wall, and in cases in which there is considerable fluid in the sac. The method of treatment will depend upon the judgment of the physician in a given case; but in any case in which taxis is to be applied the patient and relatives should be told that the measure is only experimental, and that an operation may be necessary. Before endeavoring to reduce the hernia in this way the bladder should be emptied by means of a catheter if necessary. The large intestine should also be emptied by means of large enemata, and the stomach by means of a stomach-tube. This latter measure does away with the vomiting after an anæsthetic, and should never be omitted when there is fecal vomiting.

The patient should be so placed that the region of the hernia is the highest point of the abdomen, so as to relax all of the muscles in the vicinity of the hernial ring. Certain authors recommend the knee-chest position. This, however, is awkward because of the anæsthetic. In cases of inguinal and femoral hernia the thighs should always be flexed so as to relax the region. A warm bath is supposed to be of value, because it is believed to relax the muscles. This method should be repeated only in cases in which haste is not imperative or where a herniotomy is to be avoided if possible.

One of the most valuable aids to taxis is complete anæsthesia; not only because of the pain, but also because the disturbance due to the patient's moving about is done away with. Besides, the abdominal muscles are completely relaxed. There is no doubt that certain hernias are easily reducible under an anæsthetic when all other attempts prove futile. Some authors object strongly to the use of chloroform because in the absence of pain one is tempted to use too much force and do damage. Although the author as a rule condemns taxis, still there are certain concrete cases in which this method is distinctly indicated and should be applied. One should always be prepared for operation in any case, provided the hernia proves irreducible. Direct etherization of the hernia as recommended by Finkelstein may be justifiable in cases in which there is no doubt that reduction by taxis is indicated if in any way possible. The pelvis is elevated, and about every quarter of an hour a tablespoonful of ether is poured over the region of the hernia. This is kept up for about two hours. The skin should be greased so as to avoid irritation. The cold in all probability diminishes the volume of the gases contained in the intestine and stimulates peristalsis in the loop of intestine. It is therefore best to try this method at a time when it is probable that the intestine has not been severely damaged. Gussenbauer and others have applied this treatment with considerable success. In many of the cases the hernia goes back of its own accord, or after slight attempts at reduction, whereas before the application of ether all efforts were futile.

Taxis is best done by grasping the neck of the hernia with one hand and applying a slight amount of traction, while the other hand presses upon the fundus of the sac and endeavors to diminish the size of the hernia. This pressure should be done with the flat of the fingers, and not with the tips of the fingers, and only with the fingers. Any pressure of the arm is to be avoided. An attempt is made to reduce the portion of the hernia that is nearest to the ring—*i. e.*, the portion that appears last. This can usually be done best from below. The pressure should be applied rhythmically and with gradually increasing force, while the hand at the neck of the sac prevents the hernia from spreading sidewise. It is sometimes of advantage to lift the hernia off from the abdominal wall and turn it alternately to one side and the other. When gurgling noises can be produced and a portion of the intestinal contents displaced, this may be considered a favorable sign; and when a portion of the hernia has been

reduced, care should be taken that this does not come down again. No definite time can be given; neither can it be stated how much force is permissible, although generally a few moments will be sufficient to indicate whether the surgeon's efforts are to be successful or not. In large hernias it is justifiable to spend a little more time, because the constriction is not liable to be so firm. After the intestine has been reduced, a finger is pushed into the hernial opening with the overlying skin. One should be convinced that the entire hernial canal is free, and that no suspicious mass can be felt within the abdomen. It should also be determined whether the sac is still outside or not. Care should be taken to prevent the hernia from coming down again by using a truss or some special bandage, such as a spica.

There are certain dangers connected with taxis. It is evident that if the intestinal wall has become friable, it may tear, and that the decomposing contents will enter the general peritoneal cavity and produce peritonitis. It has also happened that an approximately normal intestine has been ruptured by the use of too much force, and that the mesentery has been torn from the intestine for a considerable distance, followed by hemorrhage into the abdominal cavity. The amount of pressure used was so great that the sac ruptured and the water and the loops of intestine escaped into the surrounding tissues. Aside from these disastrous results, due to lack of judgment, there remains to be mentioned the apparent reduction or the reduction *en bloc*. In these cases the manipulations are to all appearances successful. The hernia becomes smaller and recedes. In spite of this the intestine is not liberated, but is simply displaced *in toto*, and the result is only apparent.

With complicated hernial sacs, consisting of several cavities, a superficial portion of the hernia may be pushed back into one of the deeper seated cavities, a condition which makes matters still worse. The so-called inguino-interstitial hernias and the inguinoperitoneal or cruroproperitoneal hernias belong to this group, as well as the diverticula of sacs. In these cases taxis is usually successful without any great amount of force, and the intestine appears movable, so that the operator comes to the conclusion that the hernia has been reduced. In other cases in which attempts at reduction are at first unsuccessful and are then increased, it may happen that the sac with its entire contents is loosened and pushed back into the abdominal cavity. Again, the parietal peritoneum is lifted off and the sac with its contents lies in the subperitoneal connective tissue. Strangulation persists and the conditions are still more unfavorable. In these cases it is to be presumed that the constriction was at the neck of the hernia itself. This accident is favored by the habit of some patients of reducing the sac after they have reduced the hernia itself. In these cases the neck of the sac may be so movable that a very slight amount of force is sufficient to produce a reduction *en bloc*, and not infrequently this accident happens to the patients themselves. The constricting ring itself is frequently small and fibrous. (Franz, Eiselsberg.) Occasionally this accident

happens by pressing upon the fundus without preventing the hernia from spreading laterally. Again it may happen that the sac ruptures in the vicinity of the ring, and that the contents escape through the tear and come to lie in the subperitoneal tissue, and in very rare cases the hernial ring will tear off entirely and the whole mass be pushed back into the abdomen. It may happen that the sac and the parietal peritoneum tear off, while the constricting ring remains and surrounds the intestine like a ligature. Hochenegg saved a case of this sort by operation. Anyone familiar with the ordinary progress of taxis will notice the variation, such as the absence of gurgling, the gradual softening of the hernia, etc. Sometimes there will be a crackling noise, such as that which accompanies the tearing of tense membranes, or the entire hernia will disappear suddenly. If a finger is introduced, one will be surprised to find in the canal itself, or immediately inside the abdomen, a firm resistance resembling the strangulated hernia. On palpating the abdomen carefully, one may be able to detect this mass as a hard, tender tumor. This is especially significant if this mass in the abdomen can be pressed down against the finger held in the canal. An examination by vagina or rectum, combined with abdominal palpation, may disclose the exact condition. By pressing over the tumor, or by coughing, it may be possible to reproduce the hernia, but the most characteristic thing is that in spite of the manipulations the patient does not experience any relief. If the individual has been anæsthetized, the condition will, of course, not be noticed until he commences to complain later. One should always remember that an accident of this sort is possible, and should always determine the conditions carefully after reduction. In accidents of this sort the only relief is in immediate operation. If it is possible to press the tumor down into the sac, a typical herniotomy may be performed; but when this is not possible, the abdominal cavity must be opened. If the tumor can be felt, it is best to open in the median line; but in the majority of cases one will be obliged to operate in the region of the hernial ring and then enlarge the opening into the peritoneal cavity. If the surgeon adheres to the general rule that only those cases of hernia in which there is no possible danger of gangrene should be subjected to taxis, then the results of operation for reduction *en bloc* will be more favorable.

Violent efforts at reduction usually result in effusion of blood, and operations after unsuccessful attempts at reduction are not classical as a rule because the tissues are infiltrated with blood. It is uncommon to find clots in the sac. The intestine itself may be injured, and there may be tears of the serosa and bloody infiltration of the intestinal wall. Injuries of this sort favor transmigration of microbes and increase the danger of gangrene. Other accidents are intestinal hemorrhage, due to laceration of the mucous membrane or to hemorrhagic infarction after thrombosis of vessels. Schnitzler and Ullmann have reported fatal cases of this sort. If taxis is tried in a case in which the hernial fluid contains pathological microbes or in which there is a

small perforation of the gut, fatal peritonitis may develop rapidly. This danger exists even in hernias that have been strangulated only a short time. The author will consider certain other disturbances that appear later in spite of successful reduction, in connection with herniotomy because these conditions develop after an open operation in the same manner. Prolonged and violent efforts at reduction are absolutely counterindicated, as is also aspiration of the hernial contents. A paralyzed loop of intestine does not close over after removal of the needle, and the chances of successfully operating are reduced. Ether sprays, as recommended by Richardson, and ice-bags may diminish the tension in large hernias that are associated with but slight symptoms of incarceration. In these cases the author does not object to the use of sand-bags or elastic pressure, as recommended of late by certain authors.

HERNIOTOMY.—The patient should always be prepared for operation before taxis is tried. The region should be shaved and scrubbed with some disinfectant after cleansing with liquids that dissolve the fat of the skin. Other things being equal, ether or chloroform will be used as an anæsthetic, but as a rule the latter is to be preferred. If it should be necessary to resect the gut, one may stop the anæsthetic at this time. When the general condition is poor—*i. e.*, with heart disease or kidney trouble—it is best to use a local anæsthetic, and some authors use local anæsthesia in all severe cases. Schleich, Mikulicz, Hofmeister, and Petersen, all recommend infiltration anæsthesia and praise its advantages. The latter author claims that the manipulations are much easier, and that if it is necessary to wash out the intestine, this can be done much more easily. Cushing[1] anæsthetizes the iliohypogastric nerve at the lower margin of the internal oblique and the ilioinguinal and genitocrural in the inguinal canal with a 0.5 to 1 per cent. solution of cocaine. Mikulicz reports inflammatory conditions of the lungs after infiltration anæsthesia, processes ordinarily claimed to be due to the use of a general anæsthetic.

Herniotomy may be subdivided as follows: 1, skin-incision; 2, exposure of the sac; 3, opening the sac; 4, relieving the constriction and inspecting the viscera; 5, reduction; 6, digital examination of the abdominal cavity; and 7, obliteration of the hernial opening and canal.

Generally speaking, the skin-incision is made over the most prominent portion of the hernia; in inguinal ruptures therefore from the region of the external ring downward over the scrotum; in femoral hernias, from about the level of Poupart's ligament downward over the large vessels to the lower margin of the hernia, and in umbilical hernias a longitudinal incision is usually made. One should be careful not to injure the sac or the intestine, an accident that may readily occur in femoral hernias, and in hernias where there is considerable cicatricial tissue because of some previous inflammation or when the patient has previously been operated for a hernia.

[1] Lilienthal, *Ann. of Surgery*; Matas, *Ibid.*

The length of the incision depends largely upon the individual operator, but as a rule one should not make a larger incision than is absolutely necessary, because the wounds do not always heal without complication. The incision at any rate should be sufficient to expose the field of operation thoroughly. It is customary when operating after Bassini's method to make the incision over the inguinal region.

If the individual layers covering the sac are dissected off one by one, there will be considerable laceration of tissue, so that it is much better to carry the dissection down to the sac in the region of the neck and then strip off all the layers together with a piece of gauze or with the handle of a scalpel. It is always easier to dissect out a sac while it is unopened and under tension. If, however, there is any suspicion that the hernia is gangrenous, or that there is pus in the sac, then the amount of laceration and dissection should be limited as much as possible. The overlying layers are of interest anatomically and in connection with the development of hernias, but are of little practical importance, and frequently cannot be found because of variations and secondary changes, such as adhesions, etc.

When the sac contains fluid, it may easily be recognized. It is somewhat more dense than the overlying layers, and frequently contains very few vessels. Sometimes the intestine or the omentum can be seen to move within. The accessory layers are sometimes enormously thickened, or are so adherent to the sac-wall that they form but a single layer. There may be no hernial fluid and the contents of the sac may be closely adherent, so that conditions vary extremely, and are sometimes difficult to recognize even by those most experienced.

The presence of cysts, which are not uncommon in the hernial region, makes things especially difficult, and one should always be prepared to find some anomalous condition. These cysts frequently resemble the hernial sac, or may be the result of an obliterated sac. While operating upon a femoral hernia the author found two small cysts and behind them a gangrenous hernia. Lipomata may also give rise to difficulty because the overlying layers may be mistaken for the sac and the fat itself may be mistaken for omentum. The higher up the sac is freed, the less the difficulty met, and the individual structures may be recognized and separated. The adhesions in the canal are not apt to be so great, and it is much easier to dissect the sac off from above downward.

Petit's operation without opening the sac has been discarded, and at the present time all surgeons open the sac and inspect the contents. The wall is lifted off in two places and a small nick made with a knife. When fluid runs out of the opening, it is easy to introduce a director and enlarge the opening; but when there is no fluid in the sac those places are avoided where the intestine is in close approximation to the wall. If no place can be found where the intestine is not in contact with the sac, then it may be better to open the sac by blunt dissection with forceps or a director. One should always remember that one may open in a place where the sac-wall consists of the attach-

ment of the large intestine, for instance. The muscular structure of the intestine will indicate the condition; but if the intestine is opened, it should be closed again immediately and an attack made upon the opposite side of the sac. The liquid contained in the sac should be received in a sterile dish and examined as to quantity and quality. One cannot draw positive conclusions as to the condition of the gut from the nature of the fluid, but a certain amount of information can be obtained. If the fluid is clear and serous, the intestine is in all probability in good condition. The presence of a little blood-pigment or of blood is not indicative of serious trouble. If the odor is bad, the conditions are apt to be more troublesome, although at times the water may be very foul and the intestine be perfectly viable. When the hernial fluid is cloudy, or there are bits of fibrin, the intestine will be gangrenous in all probability, and there will be no doubt at all when on opening the sac gas and fecal matter escape. In any case it is probably best to wash out the sac with some antiseptic solution and remove the micro-organisms mechanically as thoroughly as possible. The sac is then wiped out with considerable care so as not to push the intestine back into the abdominal cavity.

The constricted region of the intestine should be carefully examined, because there is frequently considerable damage here while the remaining portion of the gut does not show much disturbance. For the purpose of inspection, the strangulated gut should be pulled down, a step that can be taken without preliminary division of the constriction bands only in very exceptional cases. It is a distinct advance that the constriction band is no longer divided with Cooper's hernia-knife, but dissected down to the constriction layer by layer. Any method which is associated with the danger of still further damaging a loop of intestine that is already in a precarious condition is to be condemned. When a loop of intestine is pretty nearly ruptured, and is held intact only by the adhesions around the constriction bands, any additional pressure, such as that used by introducing a director into the ring or by pulling upon the loop of intestine, will be sufficient to tear the gut. The backed-up fecal matter rushes out and will almost always infect the peritoneal cavity with disastrous result. The author therefore prefers to dissect down to the constricting band layer by layer and tie off the vessels one by one, cut adhesion bands, and avoid traction upon the intestine, so that the friable loop of gut is exposed and isolated with the least amount of damage. It is sometimes advisable to make the first incision over the neck of the sac and expose this before the sac itself is opened, a method recommended by Bassini in his first publication. The skin-incision is made over the inguinal region, and the aponeurosis of the external oblique is split as far as the internal ring. The cord and the sac are lifted out of their bed, the sac separated without any traction being put upon the neck, and the constricting portion divided. Reduction of the hernia is very easy with this method, and radical operation may follow if advisable, just as if the hernia had been reducible from the start. This method

is especially to be recommended in cases in which there is marked strangulation, although the intestine is perfectly viable; but in those cases in which the intestine is already gangrenous there is danger that the liberated loop of intestine may slip back into the abdominal cavity before it has been thoroughly inspected. This method therefore should not be used in cases in which there is great probability that the gut has been severely damaged. In these it is best to open the sac and fix the suspicious loop of intestine externally, and then open up the aponeurosis of the external oblique and remove the constricting band secondarily. In some cases the incision over the sac is simply carried upward. There are no hard-and-fast rules that can be given which may be followed in recognizing the condition of the gut. In the majority of cases an experienced operator will know whether to replace the gut or not, but in doubtful cases even the most experienced will be uncertain. Generally the sense of touch will give more reliable information than inspection. A viable loop of intestine will contract distinctly or show some change after the constriction has been removed, and on palpation a viable loop of intestine gives one the tense feeling of living tissue, whereas lifeless gut is absolutely flaccid and resembles moist blotting-paper. If it is possible to palpate the mesentery, one should investigate the arterial pulsation in this region. When this is absent, the intestine is in great danger. The color of the intestine does not give accurate information. Even dark-blue intestine may be perfectly viable; but when there are dirty grayish-brown spots the intestine is in all probability gangrenous. Certain authors advise scratching with a needle; but this is not to be recommended, because it gives no reliable information. If there is any doubt as to the condition, it may at times be of value to move the intestine about in warm salt solution, when it will be soon seen whether the consistence improves or not.

If one has come to the conclusion that the intestine may be replaced, this should be done in such a way that the hernia cannot come down again on straining. The omentum is frequently in good condition even when the intestine has become gangrenous, although it frequently shows changes that lead one to consider that it is best not to replace it. One should not be too radical in this direction, because a thick omental stump may become adherent in the region of the hernial ring and later cause internal strangulation. If the omentum is inflamed and extensively adherent, either in its individual parts or rolled up and adherent to the sac, or when certain portions are thrombosed, there is no doubt that it is better to pull it down and tie it off where it is healthy. These ligatures should not be *en masse*, but should be near together, because this is the best way of avoiding secondary hemorrhage, and there is less liability to the formation of strands and adhesions between the intestine and the abdominal wall. A piece of omentum that has been pulled down for the purpose of ligating off slips back into the abdominal cavity very readily, whereas omentum that has been rolled up and inflamed is very

apt to stick in the region of the hernial ring and produce undesirable complications. Any adhesions between the sac and the omentum should always be tied off. When the intestine is adherent to the sac, it may be very difficult to separate the two because of the danger of tearing the gut. Rather than use force, it is better to resect a portion of the sac and leave it adherent to the gut that is to be replaced. In very exceptional cases the adhesions are so extensive that the gut cannot be unfolded. In these cases the intestine cannot be replaced or the whole loop may have to be resected. Eiselsberg resected 3.5 metres (11 feet) of intestine in a case of this sort.

Even when the hernial ring has been considerably enlarged there may be great difficulty in replacing the gut. The manipulations are the same as those of taxis. The portion of the gut nearest to the ring is first replaced after an attempt has been made to squeeze the contents of the gut back into the abdominal cavity before replacing the loop itself. If the surgeon does not succeed with one loop, he should try another, because not infrequently the ease with which the second loop slips back is surprising. If one piece of gut has been replaced, it is usually easy to replace the rest. Cases, however, occur, especially large inguinal hernias, in which the difficulties can be overcome only after the contents of the gut have been drawn off with a small aspirating-needle. The wound should always be closed with a stitch. If the contents are chiefly fecal, it may be necessary to use a large-sized trocar or incise the gut transversely, which is still better. It is evident that the wound must be carefully protected against infection. It should be packed with gauze and covered with a piece of rubber tissue that has been soaked in sublimate solution. This forms a smooth surface to which the fecal matter does not adhere and can be easily washed off. After the intestine has been emptied in this way it is usually easy to reduce the entire hernia. Sometimes the loop that has come down is twisted around its axis, an accident that interferes considerably with reduction. When this is untwisted, however, the gut usually slips back very readily.

After replacing the intestine a finger should be introduced through the hernial canal into the abdominal cavity, so as to ascertain whether the inner surface of the hernial ring is perfectly free, and whether the loops of intestine in the immediate vicinity are perfectly soft and movable. One should not overlook the fact that reduction *en bloc* sometimes occurs even after herniotomy. One should remember especially that the intestine may escape into the subperitoneal connective tissue through the openings that have been made while dividing the constricting ring, or that the intestine may slip into a pocket or a split formed by an adherent strand of omentum in the region of the ring.

There seems to be no uniform opinion with reference to treatment when the intestine is gangrenous. Hofmeister and Petersen are of the opinion that the gut should be resected immediately. This method of treatment corresponds also to the views of Kocher, Körte, and Mikulicz. When the intestine is gangrenous, the abdominal incision should be

enlarged, and the intestine should be carefully exposed, emptied, and the gangrenous portion resected with any portion that does not seem perfectly viable. An end-to-end suture or a Murphy button may be used. An artificial anus should be resorted to only in exceptional and desperate cases. The following rules should be obeyed, so as to diminish the danger of this operation as much as possible:

General anæsthesia should be replaced by local anæsthesia on account of the damage done to the heart by the absorption of toxins. The room should be warm, the table heated, and the abdomen and exposed intestine carefully covered so as to avoid any great loss of heat. It is absolutely necessary to make the opening in the abdominal wall sufficiently large to examine the intestine conveniently, which will also aid in avoiding infection of the abdominal cavity and facilitate an examination for the purpose of determining whether there remains any constriction in the region of the hernial ring. Sometimes the situation is very difficult: the gangrenous portion of the intestine may be so large that on opening the sac no healthy intestinal wall can be seen. In these cases one must be very careful not to let the ends of the intestine that are only loosely connected with the hernial ring by adhesions slip back into the abdominal cavity. A similar danger has to be dealt with at times in cases of hernia of the lateral wall of the intestine. Pressure from below should be avoided, and if possible the gut should be grasped and held in place while the abdominal cavity is being opened. If needs be, the hernial ring may be covered with a gauze pad on the inside after opening the abdomen, which closes the sac off from the peritoneal cavity. The examination of the freed intestine should be very careful and rapid, and the peritoneal cavity should be walled off in every direction with gauze. It is also necessary to empty the intestine of the decomposed matter, which may be done perfectly well if a little care is exercised. Hofmeister advocates dividing the distal end of the intestine transversely and drawing the proximal end out over the leg or over the edge of the table if possible. If necessary, the mesentery may be divided. Petersen recommends that the intestine be washed out with a tube. The amount of intestine to be resected does not depend so much upon the gangrenous area as upon the consistence of the proximal piece of intestine. One should never be afraid of resecting too much, and as a rule it is necessary to cut away several times as much intestine as is gangrenous. Hofmeister resected on an average about six and a half times as much intestine as was absolutely gangrenous, although many of his cases had only 4 cm. (1.6 inches) of gangrenous gut, and 5 of the cases were hernias of the lateral wall. In one case 4 cm. (1.6 inches) of the intestine were gangrenous, and 75 cm. (29 inches) had to be resected. Kocher considers that distinct pulsation is the most valuable sign of good nutrition, and that one should err on the side of resecting too much rather than operate through doubtful tissue. According to Trzebicky, 2.8 metres (9 feet) of intestine may be resected without interfering with nutrition, and Fautino resected 3.1 metres (10 feet) and Ruggi 3.3 metres (10.8

feet) without any evidence of subsequent disturbance. Kocher considers that the mesentery is best tied off in small pieces close to the intestine, after previously crushing with pressure-forceps. Hofmeister usually takes out a wedge-shaped piece. Kocher usually makes an end-to-end suture with double continuous stitches. Hofmeister insists upon a lateral anastomosis, after Frey, with an opening at least 6 cm. (2.4 inches) long. While placing the first two rows of sutures the proximal ends of the gut which is to be resected may be pulled out over the edge of the table so as to drain off the fecal contents. The conditions favoring nutrition are very good with lateral anastomosis, and the opening should be made as near as possible to the mesentery so as to have the normal function restored immediately. (Küttner.) Czerny prefers a Murphy button, and Petersen considers that his good results are largely due to the use of this appliance. The amount of time saved is considerable and the joint is perfect from the first. The button is discharged as a rule in about eleven days. After an end-to-end suture, the intestine is washed off repeatedly with warm normal salt solution and then replaced in the abdominal cavity in a position that favors passage of the intestinal contents. This is important because a piece of intestine that has been united by sutures has lost a certain amount of its power of motion. A radical operation may be done after an intestinal resection only in very favorable cases; for instance, after resection for hernia of the lateral wall of the intestine where the gut was not ruptured. In all other cases, and especially in the cases in which there is considerable fluid in the abdominal cavity, it is best to pack the wound. This packing should not plug things off, but should act as a drain. Those cases in which there is extensive perihernial suppuration or general peritonitis, and those cases in which the general condition is bad, should not be operated upon in this manner. According to Hofmeister, when one decides to make an artificial anus, it is practically synonymous with declaring the case lost.

One should never replace a loop of intestine when there is any doubt as to its condition. If the general condition is fair, and if the surgeon has operated with local anæsthesia, it may be well to follow Kuzmik's advice and split the hernial ring, place the loop of intestine in question between two moist gauze compresses, and allow warm salt solution (40° C., 104° F.) to flow over the gut for about half an hour. Sometimes the intestine will recover completely and pulsation may be restored in the vessels of the mesentery. If any doubt remains, the loop should be resected. Various authors have recommended leaving the gut exposed upon the abdominal wall and awaiting developments. The results of this method of treatment have not been especially favorable, because it is evident that the intestine is at a disadvantage, and after a certain time it is difficult to replace the loop. The passage of feces is interfered with, and the proximal piece of intestine is placed under very disadvantageous conditions. Adhesions and kinks occur frequently. In Tübingen 3 of 4 of the patients treated in this way died. After resection of any hernia, when the wound is left open,

with or without resection of gut, it is well to pass a long rubber ligature through a neighboring part of healthy mesentery, allowing both ends to lie in the wound firmly tied together. By traction on this ligature the involved gut may be withdrawn for inspection. When the danger has passed the ligature may be easily withdrawn. (Lilienthal.)

Helferich recommends lateral anastomosis between the proximal and distal portion of the intestine above and below the gangrenous area. This opening should be about 4 cm. (1.6 inches) long, and allows the fecal contents to pass into the healthy gut below without touching the suspicious loop of intestine. This places the damaged gut under very favorable conditions, especially as it is not distended. The anastomosis is replaced within the abdominal cavity, while the suspicious portion of the gut is left outside. If the intestine recovers, it may be replaced; but even if it becomes gangrenous, the conditions are comparatively favorable, because a large part of the fecal contents passes through the anastomosis and the fecal fistula formed closes within a short time. Although this method seems very plausible, still the author prefers to resect the intestine, because the amount of interference is practically the same. If there is any reason for not resecting, Riedel's method of drawing the loop of intestine out of the hernial ring and opening the same for the purpose of emptying, may be made use of. Within a short time a sharp line of demarcation forms. These patients recover from the shock of strangulation provided there has been no peritonitis, and in the course of twenty-four to forty-eight hours the intestine may be resected under much more favorable conditions because it is easier to distinguish the limits of the healthy intestine. Besides this, the immediate danger is much less. Most of the fatal cases after primary resection occurred in the first twenty-four hours after operation. The method of uniting the intestine over small gangrenous areas, or over suspicious areas, especially in the region that has been constricted, is dangerous and not to be recommended. Fatal perforation took place in 3 of 5 cases in the Heidelberg clinic, and there is also danger of stenosis on account of the extensive invagination. Should it after all be considered advisable in a given case to turn such doubtful or gangrenous patches into the gut by suture, subsequent stricture may be avoided by suturing so that the line of suture will be circumferential, not longitudinal. (Lilienthal.) It is much better to resect, and in many cases a wedge-shaped piece may be taken out of the gut without operating upon the mesentery. As far as an artificial anus is concerned, it would be most convenient simply to amputate the gangrenous portion of the intestine. This, however, is frequently not sufficient to give the perfectly free passage that is necessary if the operation is to be in any way successful. Should division of the hernial ring also prove insufficient, then the intestine must be drawn down and tacked to the sac with a few stitches. In spite of these measures the intestine at times does not empty itself, the gangrene progresses, and fatal peritonitis results.

Statistics.—Bruns and Hofmeister report 64 herniotomies with a total mortality of 22 per cent., 25 of the cases having gangrenous intestine:

	Cases.	Died.	Per cent.
Artificial anus	5	4	80
Exposure of suspicious loop	4	3	75
Primary resection	17	4	23

Petersen, in Czerny's clinic, reports 74 herniotomies with 17 cases of gangrene:

	Cases.	Died.	Per cent.
Artificial anus	5	5	100
Primary resection	12	1	8

The following table is taken from Hofmeister's work:

	Artificial anus.	Died.	Primary resection.	Died.
Maydl	12	5	9	2
Krönlein	15	13	12	8
Braun	7	6	8	3
Körte	23	16	3	1
Helferich	8	7	12	6
Hahn	—	—	18	5
Bramann	66	30	2	1
Czerny	11	8	5	3
Meleschko	13	8	1	—
Eiselsberg	1	1	8	5
Wilms	3	2	6	2
Obalinski	—	—	74	41
Socin	3	1	20	12
Springorum	—	—	19	6
Hofmeister	5	4	17	4
Petersen	5	5	12	1
	172	106 (61.6 per cent.)	226	100 (44.2 per cent.)

If Bramann's cases are not taken in consideration, the death-rate from artificial anus will be 71.7 per cent.

After replacing the gut a radical operation may be performed if there are no counterindications. Eiselsberg operated 48 times, and was obliged to omit the radical operation only 4 times. If there is suppuration in the hernial sac, or if a large quantity of clear serum or cloudy or foul-smelling exudate flows from the peritoneal cavity after opening the hernial ring, or if an extensive resection is performed on intestine the vitality of which is doubtful, and finally if the sac or the neck of the sac has become infected with pus or feces during the operation, then a radical operation should be omitted. In all of these cases it is better to leave the hernial ring open and pack with iodoform gauze, or put in a rubber or glass drain surrounded with gauze. It may be possible to close the hernial ring in a few days by a secondary operation, provided no harmful after-effects appear, or the wound may be allowed to heal by second intention under continued packing. If there is some doubt but still hope that the case will progress favorably, then provisional sutures may be placed that can be tied within a few days.

It is best in these cases to knot each individual suture separately. If the hernial ring has been cared for, then the external wound may be closed so as to have healing by first intention. It is not uncommon to have some disturbance after operations of this sort, especially in the superficial layers, and for this reason it is frequently advisable to close only the lower layers, and to keep the skin-wound open for several days with a thin iodoform gauze drain. This may be eventually removed and the wound closed by secondary suture or allowed to heal by second intention. The dressing should consist of some absorbent material held down by strips of adhesive plaster. Formerly opium was always given after an operation for strangulated hernia, so as to rest the injured intestine and with the idea of preventing peritonitis. At the present time opium is given only when there is some distinct indication. After an early operation which has been uncomplicated there is no more reason for giving opium than after any laparotomy. In the cases in which there has been gangrene of the gut, in which there has been a resection performed the result of which is doubtful, or when there is reason to suspect that the abdominal cavity has become infected, it may be well to give twenty drops of the tincture of opium four times a day, so as to limit peristalsis and allow adhesions to form which tend to wall off the pus. It is best not to give food until the bowels have moved and the general condition of the patient has improved sufficiently to show some return of appetite.

If the operation is performed before there are any severe changes in the bowel, it is common to have recovery undisturbed. Within a few hours after relieving the obstruction the patient has a movement of the bowels or a large quantity of gas is passed. The nausea and vomiting cease, the temperature may become subnormal, and the dry tongue becomes moist again. If the strangulation has lasted for some time and there is considerable decomposed fecal matter in the intestine with some disturbance of nutrition, the pulse may remain small and rapid, and the temperature frequently rises within a few days to 38.5° C. (101° F.). The tongue remains coated and the patients suffer from nausea, vomiting, and headache. Not infrequently there is profuse diarrhœa; large quantities of foul-smelling, dirty brown fluid feces are passed with considerable pain. The symptoms are due to poisoning secondary to absorption from the intestinal tract. These patients should be stimulated by injections of camphor or moderate doses of alcohol, repeated subcutaneous infusions of normal salt solution, poultices, etc. Sometimes bismuth and opium are of value. If there is no movement of the bowels for several days, and at the same time there are no symptoms of strangulation, there is no cause for worry as a rule, and it is justifiable to wait for three or four days. If, however, there is a sense of discomfort in the abdomen—slight distention—it may be possible to remove the symptom by high injections of oil or by using castor oil by mouth. There are cases in which the bowels do not move in spite of these measures. The general condition improves after relieving the constriction, and to all appearances there is no

danger. After three or four days, however, the abdomen commences to swell. Vomiting reappears, which may even be fecal in character, although there are no symptoms indicating peritonitis or internal strangulation. Treatment is useless and the patients die of inanition within a few days. On autopsy there is no sign of peritonitis or of obstruction, but the loop of intestine which was strangulated is found completely collapsed and the gut above enormously distended with fecal matter. The condition is really one of paralytic obstruction. The constriction was not sufficient to produce gangrene, but was sufficient to cause permanent disturbance of circulation with subsequent paralysis of the muscles.

Secondary internal intestinal obstruction after herniotomy is not uncommon. The replaced intestine may become caught over a strand of omentum, or the gut may become adherent to the abdominal wall or twisted in its longitudinal axis. Besides this there are the cases of apparent reduction described in connection with taxis. The symptoms of internal incarceration may follow the signs of strangulated hernia immediately, and the only way to relieve the condition is by immediate abdominal section. The conditions are much more difficult when the signs of obstruction are relieved after herniotomy and the bowels have moved before signs of obstruction appear again. If there are inflammatory changes in the intestine, one will not hesitate to interfere radically because of the great probability that adhesions will be found. The questions that arise in this connection are extremely difficult to decide, for peritonitis may produce a very similar clinical picture.

Infection may have taken place at the time of operation, although this is uncommon with modern technic, as shown by statistics. The most common cause is that a loop of intestine, supposedly healthy, has suffered sufficiently to become gangrenous after being replaced, and that very fulminating septic peritonitis develops as soon as the gut ruptures. Sometimes an abscess forms around the gangrenous area and general infection of the peritoneal cavity takes place more slowly. This sort of peritonitis develops as a rule after one or two days. There are, however, cases in which severe peritonitis develops immediately after the operation, and the temperature rises to 39° C. (102° F.) on the first day, followed by a fatal termination within a short time. In all probability, infected hernial fluid enters the peritoneal cavity in these cases, for it is uncommon to find any gangrene of the intestine on autopsy. The differential diagnosis between intestinal obstruction and peritonitis is considered elsewhere; but if there is reason to suppose that there is a diffuse peritonitis, the abdomen should be opened immediately.

If there is localized suppuration, the condition is treated on general principles. After resection of the intestine it is not uncommon to have localized suppuration. The pus finds its way to the hernial ring, chiefly because the loop of intestine lies in this region and is apt to be bound to the abdominal wall by adhesions. In these cases the wound should be freely opened and the abscess drained so as to prevent infec-

tion of the general peritoneal cavity, and not infrequently the case terminates favorably after removal of the pus even when it contains fecal matter. A fecal fistula may remain for some time, but as a rule closes of its own accord. After inguinal hernia gangrene of the testicle is sometimes observed. When the cord is spread out over the hernial sac, the spermatic artery is at times injured in spite of all precautions. This accident is followed by gangrene of the testicle. The wound may heal by first intention, but after a few days the scrotum swells, becomes red, and fluctuates. If the wound is open, thin pus escapes mixed with shreds of tissue. Little by little other shreds of tissue come away and the thickening of the scrotum persists. Finally larger pieces appear, and if traction is made on these the testicle may come away *in toto*. Alarming symptoms of intestinal obstruction sometimes appear after the operation. These may appear when a suspicious piece of intestine has been inverted or when large ulcers of the intestine heal within the lumen of the gut when there has been no perforation. Garrè reports an interesting case in which extensive cicatricial stenosis followed gangrene of the mucous membrane of a strangulated loop.

Artificial Anus.—Sometimes these cases terminate quite favorably if the overlying tissues rupture at about the same time that the intestinal wall gives way, so that the fecal matter is allowed to escape. As a rule this does not take place, and large cavities form filled with decomposing matter and fresh abscesses and pockets appear again and again. One should make large and free incisions, so as to drain these pus cavities, and be careful that there is no obstruction to the passage of feces from the ruptured gut.

When making an artificial anus, one should render the conditions of the wound as simple as possible, and, although the operation takes but little time, many of these patients die within the first days because they become exhausted, or peritonitis develops in spite of the artificial opening or perhaps existed beforehand. The wound cannot be treated antiseptically, of course, but should be packed with iodoform gauze without obstructing the passage of intestinal contents. Some absorbing material should be placed over the opening and changed frequently. The surrounding skin should be covered with vaselin. In spite of these precautions it is not uncommon to have extensive eczema, pustules, and ulcers, because the entire region is constantly bathed in fecal matter. The wound itself cleans up very slowly, and it is of advantage to place patients of this sort in a permanent bath, or at least have them in a bath for several hours, which favors cleaning up of the wound.

Attempts have been made to nourish these patients by injections, not only by rectum, but also through the artificial opening. These experiments have not been very satisfactory, for the material runs out unaltered, either because of some mechanical obstruction or because of the antiperistaltic movements. The danger of death from inanition is great, and one is not infrequently obliged to close the opening early

after separating the ends of the intestine and uniting them as rapidly as possible. The author speaks of a fecal fistula when only a portion of the fecal contents escapes through the opening. With an artificial anus all of the fecal matter escapes through the new opening and the intestine below remains empty. Fecal fistulas are more apt to be found in connection with strangulated hernias of the wall of the intestine, whereas an artificial anus is produced whenever an entire loop of intestine becomes gangrenous. The adjacent surfaces of the proximal and distal ends of the gut adhere to each other, and after the loop has been thrown off both openings appear side by side, separated by one partition, consisting of the portion of the gut where the mesentery is attached. This partition, which is called the "spur," is somewhat more prominent, and prevents fecal matter from the proximal end entering the distal portion of the gut. This latter portion rapidly diminishes in size because of disuse, and it may be extremely difficult to find the lumen. The mucous membrane of the proximal end is frequently prolapsed, and may become adherent to the skin, while the surrounding region heals with extensive scar formation.

The skin around a fecal fistula is frequently much irritated, and it is not uncommon to have many sinuses beneath the surface opening in various places. These sinuses are the remains of suppuration that took place before the abscess ruptured. They may heal or fresh fecal matter may lodge in them and produce suppuration. Small fecal fistulas may heal independently, but large ones and an artificial anus never heal spontaneously. The spur must first be removed, and recovery takes place only when the obstruction to the passage of feces into the lower end of the bowel is completely removed.

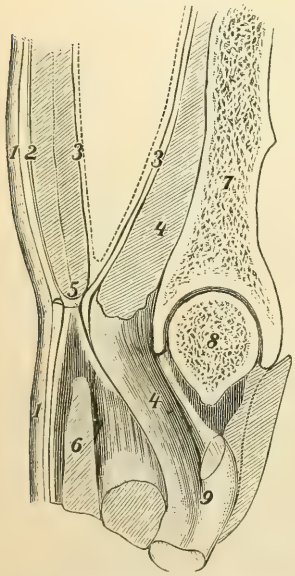
CHAPTER XXII.

VARIETIES OF HERNIA.

INGUINAL HERNIA.

An inguinal hernia leaves the abdominal cavity above Poupart's ligament, which stretches between the anterior spine and the symphysis, and consists chiefly of the lower free margin of the aponeurosis of the external oblique muscle. This ligament is reinforced by the iliac fascia, by the fascia transversalis, by the superficial fascia, by the superficial layer of the fascia lata, and by the femoral portion of the iliac fascia. After separating the skin the cord will be seen at the side of the symphysis, covered with loose fat and connective tissue. The testicle develops at about the level of the third lumbar vertebra, and lies upon the fascia immediately behind the peritoneum. The spermatic vessels enter through the mesorchium, the spermatic artery on the left side from the aorta and on the right side from the renal artery; the spermatic vein on the left side from the renal vein and on the right side from the vena cava; and the spermatic nerve from the genitocrural. At the end of the third month a cord can be detected connecting the lower end of the testicle close to the epididymis with the internal oblique and transversalis muscles, and leading down along the track which the testicle follows later. This strand is the gubernaculum Hunteri. The testicle descends into this and becomes partially surrounded, and at the end of the seventh month reaches the fundus of the sac. The testicle is intimately adherent to the peritoneum, and the external covering becomes blended with this membrane, so that on descending it drags the peritoneum down with it. The peritoneum previously forms a pouch in the region of the internal ring, and the testicle enters this at about the sixth month and then follows along the inguinal canal down into the scrotum. The portion of

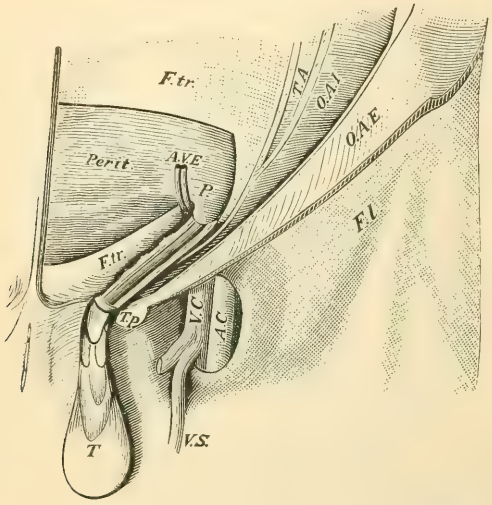
Fig. 237.



Sagittal section through the lacuna muscularis, to show the fascia: 1, superficial fascia; 2, aponeurosis of the external oblique; 3, abdominal fascia, transversalis in front and iliac behind; 4, psoas; 5, Poupart's ligament; 6, sartorius; 7, ilium; 8, head of the femur; 9, lesser trochanter; two layers of the fascia lata pass from below to Poupart's ligament; the dotted line is the peritoneum. (Henle.)

the peritoneum accompanying the testicle into the scrotum is called the processus vaginalis peritonei, and the first bulging of the peritoneum is called Seiler's blind sac. After the testicle has reached the scrotum the larger part of the tunica vaginalis above becomes obliterated. Only that portion remains which surrounds the testicle itself and forms the tunica vaginalis propria testis. The internal abdominal fascia, or the fascia transversalis, is also pushed down ahead of the testicle, and covers the whole structure as the tunica vaginalis communis funiculi spermatici et testis. This layer is covered with structures taken from the external abdominal wall, such as muscle-fibres

FIG. 238.



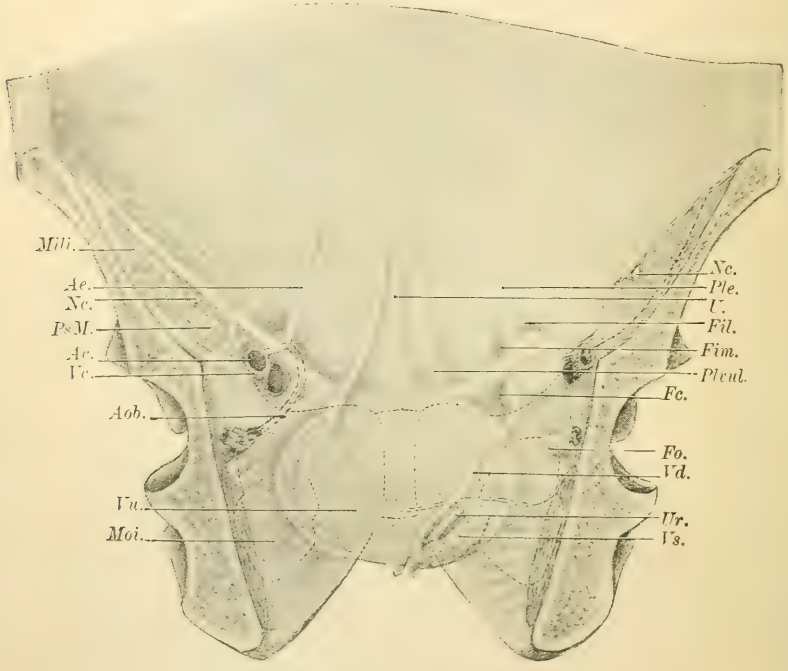
Showing the inguinal canal, abdominal muscles and fascia transversalis partially removed. Tunica vaginalis communis removed in front. *OAE*, external oblique; *OAI*, internal oblique; *PA*, transversalis; *Tp*, tuberosity of pubes; *AVE*, deep epigastric artery and vein; *Ftr*, fascia transversalis; *Fl*, fascia lata; *P* and *Perit*, peritoneum; *T*, testicle; *AC*, femoral artery; *VS*, saphenous vein.

from the internal oblique and transversalis (cremaster), and connective-tissue fibres over the opening of the external abdominal ring (intercolumnar fibres).

If the cord is made tense in an adult, it is possible to pass the finger into the inguinal canal through the external abdominal ring, formed by a split in the aponeurosis of the external oblique muscle. The external angle is pointed, and the margins are inserted into the symphysis and spine of the pubes. These margins are called the pillars of the ring, and in women are about 7 to 10 mm. (0.28 to 0.39 inch) apart, while in men they may be 27 mm. (1 inch) apart. This split in the fascia is made a ring by the archiform fibres above and externally, and by the ligamentum collesii below and internally. The cord is surrounded by considerable connective tissue, which is attached to the margin of the ring above and represents originally the superficial abdominal fascia, or fascia of Cooper.

If the external oblique is removed, the internal oblique, which in this region is intimately adherent to the transversalis muscle, will be seen. These muscles are attached to the lateral portion of Poupart's ligament, but soon pass horizontally inward to the sheath of the rectus muscle, while Poupart's ligament runs downward and inward. Between the muscles and the ligaments is a free space for the passage of the cord. This split also varies considerably in males and females, and in men may be 3 cm. (1.4 inches) broad. Toward the median line it is covered by the sheath of the rectus muscle. Beneath this is the

FIG. 239

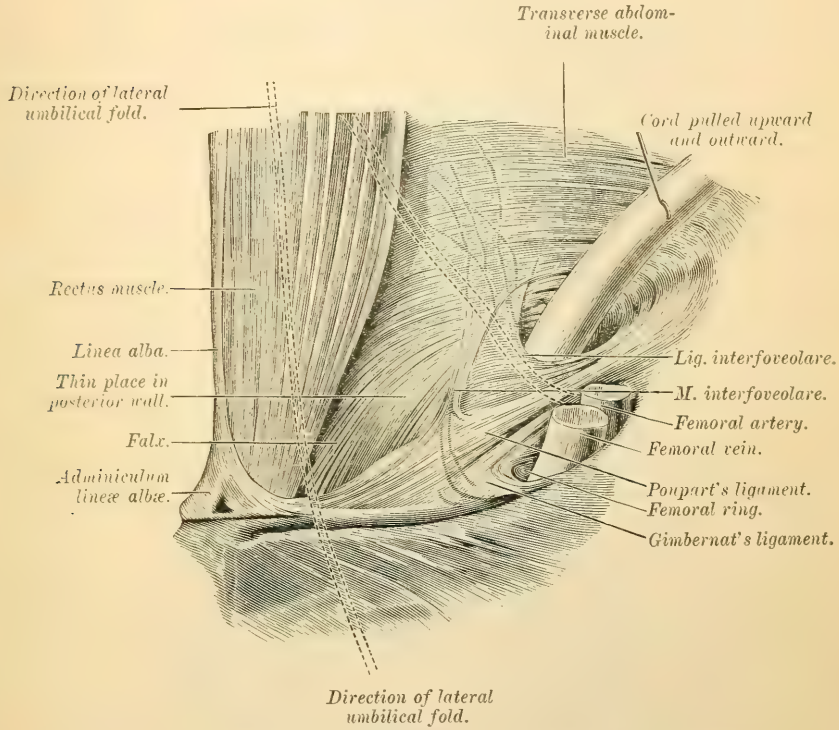


Anterior abdominal wall from within, peritoneum removed on the left side: *Mili*, internal iliac muscle; *Ae*, epigastric artery; *Nc*, crural nerve; *PsM*, psoas; *Ac*, art. cruralis; *Vc*, femoral vein; *Aob*, abnormal course of obturator; *Vu*, bladder; *Moi*, obturator internus; *Vs*, seminal vesicle; *Ur*, ureter; *Vd*, vas deferens; *Fo*, obturator foramen; *Fc*, femoral fossa; *Plvul*, lateral vesico-umbilical fold; *Fim*, internal inguinal fossa; *Fil*, external inguinal fossa; *U*, urachus; *Ple*, epigastric fold.

fascia transversalis, and then comes the subperitoneal fat, and finally the peritoneum. If the abdominal wall is seen from within, and a little tension made upward, five folds will be seen. There is, first, the plica vesico-umbilicalis medialis, reaching from the summit of the bladder to the umbilicus, and containing the obliterated urachus. Then there are two lateral folds, reaching from the side of the bladder to the umbilicus, which are the plicæ vesico-umbilicalis lateralis, and contain the obliterated hypogastric arteries. Still farther out, about half-way between the anterior superior spine and the symphysis, are

the remaining folds, which pass vertically upward and contain the deep epigastric arteries. Poupart's ligament forms a distinct band, and the places where the above-mentioned folds cross this structure are more resistant, so that the intra-abdominal pressure produces fossæ at their sides. Only those at both sides of the deep epigastric arteries are of interest to the surgeon. These are called the inguinal fossæ, one internal and one external. The internal one is on a level with and directly behind the external ring, while the external inguinal fossa is a little higher and corresponds to the place where the testicle

FIG. 240.

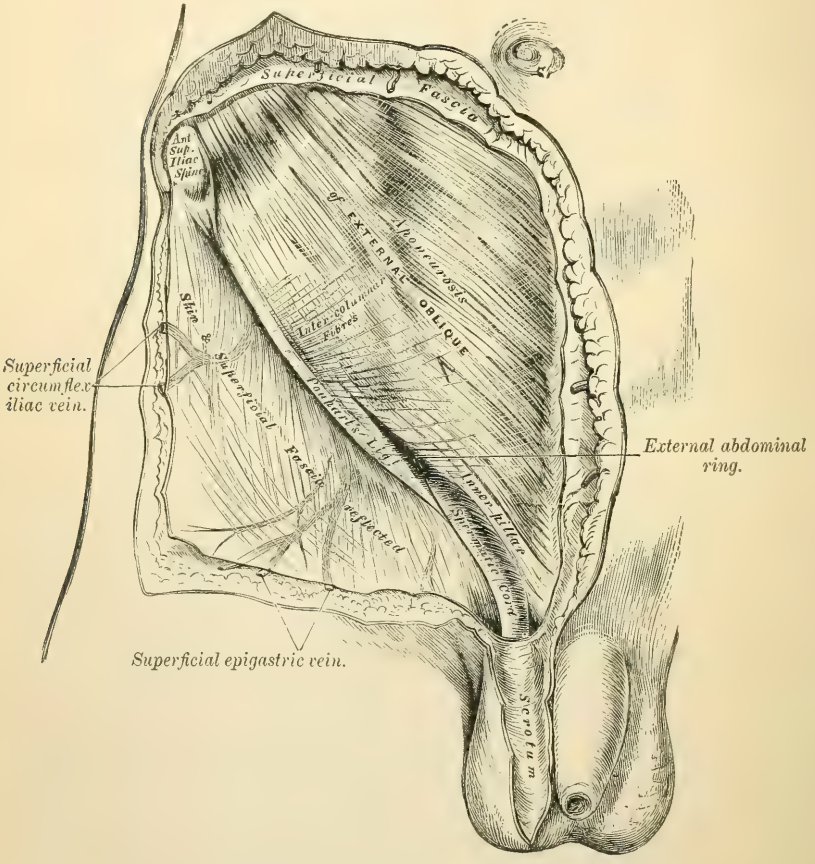


Internal inguinal ring from within after removal of the peritoneum and fascia intra-abdominalis. (Spalteholz.)

left the abdominal cavity, pushing the peritoneum and the transverse fascia ahead. The beginning of the inguinal canal is in this fossæ, and the opening is called the internal abdominal ring. If the region is inspected a little more closely, several other bands will be noticed to meet in this region. The spermatic vessels and nerves and the vas deferens meet in this region to form the cord. The canal itself between the external and internal ring is 2.5 to 5 cm. (1 to 2 inches) long, and is directed from without downward and inward. The walls are made up of various structures in the oblique course, and the opening of the canal is completely filled by the structures contained in the

cord that are held together by the common tunica vaginalis. The coverings of the testicle in the scrotum are: the tunica vaginalis propria testes, the visceral fold of which becomes united with the tunica albuginea and is formed of peritoneum. The tunica vaginalis communis consists of various parts—fascia transversalis, cremaster muscle, and intercolumnar fibres. These coverings of the testicle are surrounded by the layers of the scrotum itself, and between the two there is always a layer of loose connective tissue which allows the

FIG. 241.

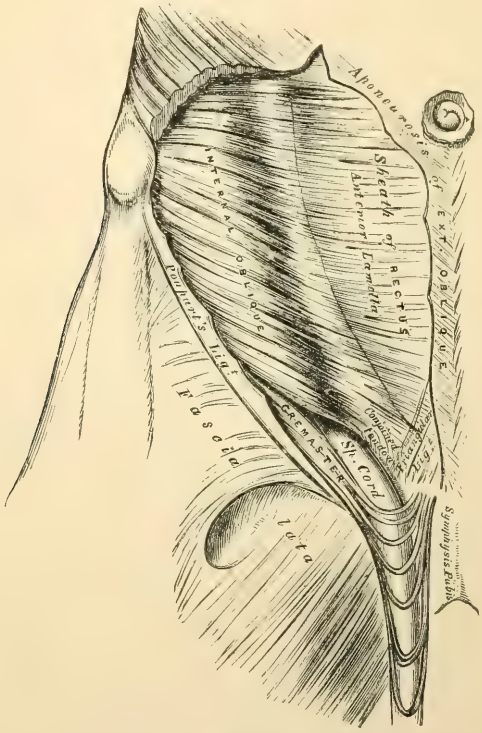


Inguinal hernia. Superficial dissection. (Gray.)

testicle to be freely movable. In the fundus of the scrotum there is a point of union between the testicle, which is a remnant of the gubernaculum. The tunica dartos is a membrane containing many smooth muscle-fibres, and is a prolongation of the superficial fascia, never containing fat. This is covered by the skin itself, containing many sebaceous cysts and hair-follicles. This skin is thrown into many folds, is very elastic, and presents in the median line a raphé extending from

the penis in front to the anus behind. The conditions are very similar in the female, although the canal is much narrower, and contains the round ligament which comes from the muscular substance of the uterus and finally becomes lost in the labia majora. This structure also contains fibres of the internal oblique. The ovary descends just as the testicle, but usually remains in the true pelvis. The gubernaculum Hunteri is partly lost in the round ligament, and a vaginal process of peritoneum is formed which soon closes. Sometimes it persists after birth, and is known as the canal of Nuck. In rare cases the

FIG. 242.



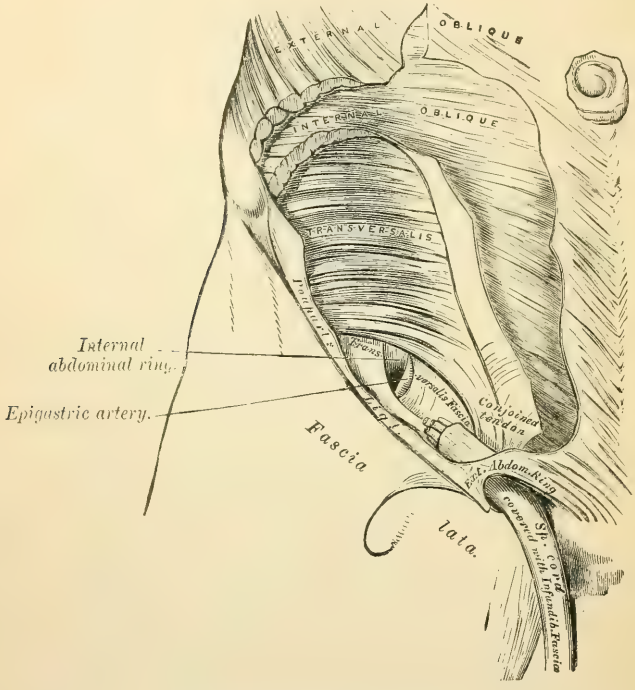
Inguinal hernia. Dissection showing the internal oblique and cremaster. (Gray.)

ovary comes down as far as the inguinal canal, and the conditions then resemble very closely those of an undescended testicle. The gubernaculum Hunteri, which originally forms the round ligament, is at first hollow, which explains how cysts of the round ligament occur at times. Other cysts may develop in the canal of Nuck.

The inguinal region predisposes to hernia because in males at about the seventh month of fœtal life there is a well-developed typical hernial sac, the processus vaginalis. It is, however, very uncommon to have any viscera enter this canal during fœtal life, and normally it closes at a time when the intra-abdominal structures are not pressed against this

weak place. After the testicle has descended, the track is surrounded by structures of little resistance, which favors the escape of viscera and explains how inguinal hernia is so much more common in boys. The inguinal canal, which is the seat of exit of a structure of considerable size, is always insecurely closed, and the tunica vaginalis communis, especially the funnel-shaped commencement, the so-called fascia infundibuliformis, favors the development of hernia. The internal inguinal fossa is produced by pressure over this less resistant region of the abdominal wall, for in the region of the external inguinal ring the wall

FIG. 243.



Inguinal hernia. Dissection showing the transversalis muscle, the transversalis fascia, and the internal abdominal ring.

is more or less completely devoid of muscular structure, and as the two places correspond so closely it can readily be understood why rupture not infrequently takes place in this region.

Oblique Inguinal Hernias.—These follow the same course that the testicle took to reach the scrotum. The route is pointed out by the course of the cord, and the hernia enters the tunica vaginalis communis which surrounds it and guides its course downward. For this reason the vast majority of oblique inguinal hernias sooner or later enter the scrotum. If an inguinal hernia is of any size and does not enter the scrotum, it is in all probability not oblique. The cord is usually behind the hernia in the region of the internal ring and throughout the entire

inguinal canal. Outside of the external ring the cord may be in front of the hernia, or it may be split up so that its structures are spread out over the sac. A fresh hernia of this sort always has an oblique course and is covered by peritoneum, subserous connective tissue and fat, tunica vaginalis communis, cremaster fibres and connective-tissue fibres from the intercolumnar fascia, superficial fascia, which in the scrotum contains smooth muscular fibres, the tunica dartos, and finally skin.

FIG. 244.

Indirect inguinal hernia (bubonocele).

Between the tunica dartos and the tunica vaginalis, and between the tunica vaginalis communis and the hernial sac, there is always some loose connective tissue, which favors separation of the layers. It is not always possible to find all of these layers, because they undergo more or less change in the course of time. A recent inguinal hernia passes through two tight places in its course—the internal and the external hernial ring. As the hernia increases, the relations change somewhat. The rings become enlarged—*i. e.*, the median portion of the internal ring and the lateral portion of the external ring—so that finally the

two almost overlie each other. The intervening structures become adherent, so that there is no longer an internal and an external opening, but a simple ring surrounding the neck of the sac. When this condition exists, the term "oblique" no longer applies, of course, for the direction is just as direct as with hernia in the internal inguinal fossæ. The relations, however, to the deep epigastric artery are unchanged. Enlargement of the inguinal rings is usually associated with

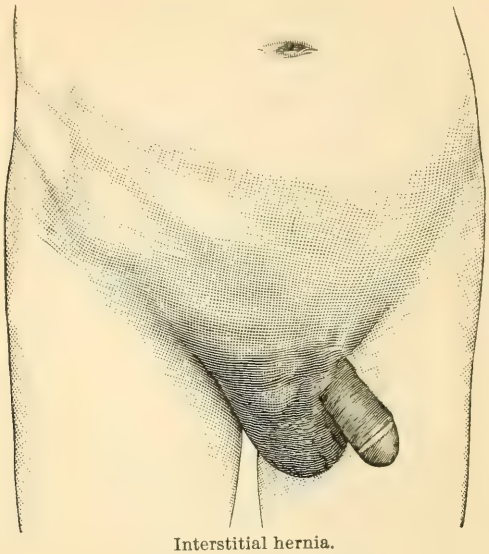
Fig. 245.

Scrotal hernia (Massachusetts General Hospital, Dr. H. H. A. Beach).

relaxation and atrophy of the muscles, especially in the region of the lower free margin of the internal oblique and transversalis. Oblique inguinal hernias are subdivided according to the stage they are in and according to their size. The inguinal ring may admit a finger easily, and on coughing an impulse of the peritoneum will be detected. This in itself is not absolute proof of a hernia; but when this condition is

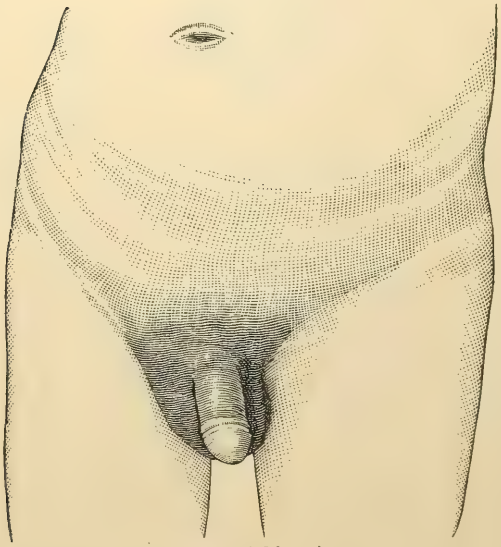
much more marked on one side than on the other, usually on the right side, it may be of corroborative diagnostic significance. If on coughing or straining some viscera enter the hernial sac and go back after

FIG. 246.



Interstitial hernia.

FIG. 247.



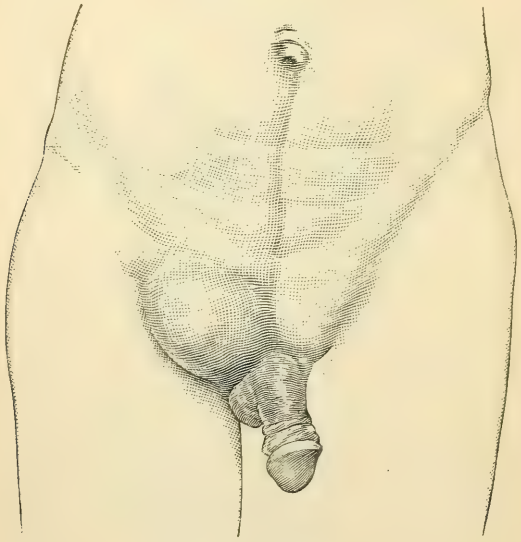
Interstitial hernia.

cessation of the applied force, and the inguinal canal is sufficiently large to admit a finger as far as the abdominal cavity, the condition is

known as a hernia incipiens—*i. e.*, a beginning hernia. The region of the inguinal ring shows much less resistance on palpation.

Kocher has reported many interesting details with reference to this stage, based on numerous early radical operations. On coughing, the inguinal canal bulges as an oval swelling, which disappears as soon as the pressure diminishes without it being necessary to replace any contents. There is a conical pocket of peritoneum produced by intra-abdominal pressure because the thin fascia transversalis and the supporting fibres in the region of the internal have finally become less resistant, and have allowed the deep abdominal muscles to be pressed apart. On operation this sac-like conical bulging will be found to be about 1 to 2 cm. (0.4 to 0.8 inch) long with the base in the region of the internal

FIG. 248.



Bubonocele.

ring. The resistance of the external ring—*i. e.*, of the aponeurosis of the external oblique—is diminished, the pillars are separated, and the intercolumnar fibres considerably stretched and pushed to one side. It is possible to press the anterior wall of the inguinal canal far inward into the abdominal cavity, and with any exertion viscera enter the conical pouch of peritoneum, but go back again immediately. A hernia proper develops as soon as some abdominal organ remains permanently within the sac; a condition that may appear suddenly due to overexertion, or gradually. Individuals with an incipient hernia are only able to escape a hernia proper by avoiding any exertion.

The third variety is made up of those cases in which the inguinal canal always contains a hernia, but in which there is no bulging of the parietes. This condition is known as an incomplete inguinal hernia. The next group consists of the cases in which there is a distinct bulging in

the inguinal region, a condition known as a complete hernia or bubonocele. Then there are the cases in which the hernia reaches into the scrotum, known as scrotal hernia; and finally there are cases in which the scrotum is very much distended, so that the entire skin in the region, including the penis, forms a covering for the rupture. Not infrequently the opening of the penis appears much like the umbilicus, and there will be much difficulty in deciding on which side the hernia belongs, because the raphé is considerably displaced. An increase in the size of the hernia is usually associated with enlargement of the hernial ring, and in very extensive cases it may be perfectly possible to introduce the entire hand through the ring. In these cases it is

FIG. 249.

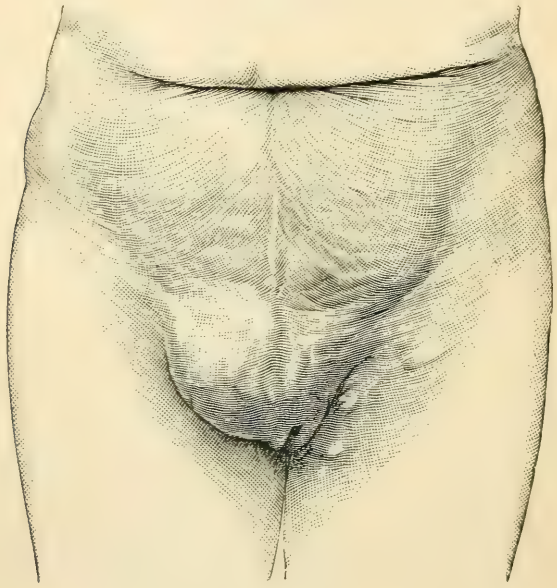
Scrotal hernia.

uncommon to have any strangulation, but the hernia is very apt to be irreducible, partly because of adhesions, partly because the hernial contents can no longer find room within the abdominal cavity. There may be very extensive evisceration, reaching down as far as the knee, and with distinct pulsation. The total of the arteries contained in one of these larger hernias is so great that each systole produces a distinct pulsation of the entire mass. The skin over large inguinal hernias is usually much changed, sometimes ulcerated or eczematous, sometimes contracted by scar-tissue, due to improper appliances or frequent wetting with urine.

Congenital Oblique Hernia in Males.—Since J. Hunter's investigations relative to the descent of the testicle, it is customary to subdivide oblique inguinal hernias into congenital and acquired. These names do

not apply to the time that the hernia appeared, but to the anatomical conditions. A congenital oblique hernia is one where the abdominal viscera have descended into the processus vaginalis peritonei, that remained partially or completely open—*i. e.*, where the testicle and the hernial contents are surrounded by one and the same serous covering. As a rule only the sac itself is congenital in these cases. With acquired oblique inguinal hernias the testicle has already descended, the processus vaginalis has closed up to the internal ring in typical cases, and the hernia is produced by a fresh bulging outward of the peritoneum, which passes along the cord into the scrotum, but which is not in direct

Fig. 250.



Labial hernia.

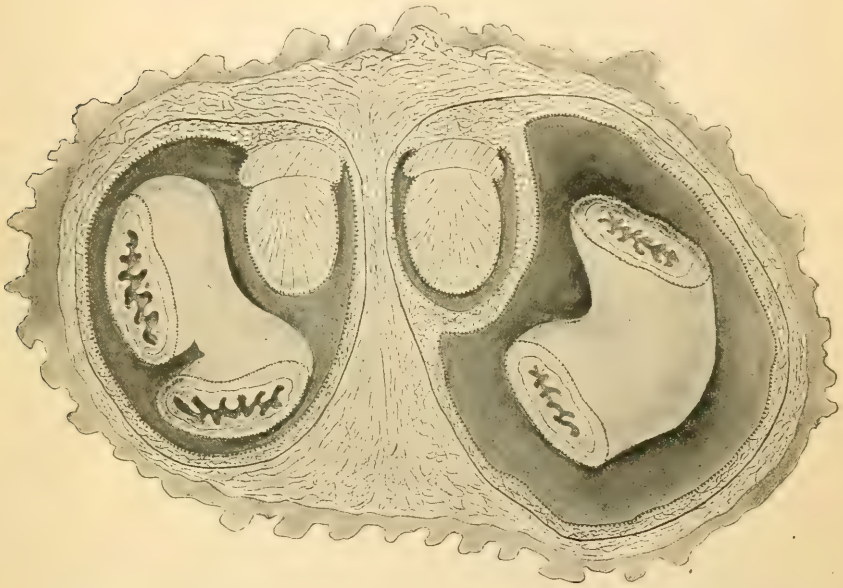
contact with the testicle. If a hernia of this sort has descended as far as the testicle, the abdominal contents and the testicle are separated by two layers of peritoneum, the tunica vaginalis propria testis and the new hernial sac. (Fig. 251.)

Congenital inguinal hernias in the strictest sense of the word—*i. e.*, those present at birth—are extremely uncommon. Even in cases in which the vaginal process is not obliterated at birth the abdominal contents do not come down immediately. Some accidental cause during the first years of life, or even when the individual is full grown, furnishes the necessary impulse to drive the viscera into the open canal. There are, however, inguinal hernias that are congenital in the truest sense of the word and are complete at birth. These have usually broad or strand-like adhesions between the hernial contents and the testicle, and it is to be assumed that these adhesions formed before the testicle

descended, and that the hernia was dragged down into the scrotum with the testicle.

The processus vaginalis is a prolongation of peritoneum not produced by traction of the testicle, but independently, and as a rule reaching farther down than the testicle itself, and being present even when this organ remains undescended. As a rule this process of peritoneum closes within the first few months after birth. Obliteration commences in the median portion of the portio funicularis and progresses downward more rapidly than upward. Even when this canal does not become obliterated there is apt to be evidence of abortive

FIG. 251.



Diagrammatic section through the scrotum of a man with two inguinal hernias. Left side of picture, congenital inguinal hernia (testicle and intestine within a common serous cavity). On the right side, acquired inguinal hernia with separate serous cavities.

attempts, represented by prominent folds or circular contractions of the sac, and which, according to Ramonede, occur rather regularly in three places: (1) in the region of the internal opening, (2) in the region of the internal ring, and (3) in the region of the external ring. Sometimes a similar condition is noted where the tunica vaginalis propria testis joins with the canal above. It is not uncommon to have the canal remain entirely patent or have it partially obliterated. Several varieties may be distinguished in this connection. The vaginal process, according to Sachs, is subdivided into the funnel, the inguinal portion, the funicular portion, and the vaginal portion (propria). The first group consists of the cases in which obliteration takes place in the middle of the funicular portion and the funnel remains open with a long tunica propria, which is wide and extends upward. In the second

group the portio funicularis is completely obliterated and the inguinal portion remains open. This is the most common variety. In the third variety only the inguinal portion is obliterated, and in the fourth the entire process is obliterated except in the region of the internal ring, where a small funnel remains with a tiny opening. When this funnel-shaped opening is present, there is usually found a valve-like fold with the concave edge directed backward and outward which serves to close the entrance to the canal. This fold consists of peritoneum and fascia infundibuliformis. (Zuckerkandl, Ramonede.) Besides these cases there are very irregular conditions in which the canal becomes obliterated in several places, leaving spindle-shaped cavities between that not infrequently become filled with serum. It is not uncommon to have some abnormality in the position of the testicle associated with disturbances of obliteration. P. Camper found the vaginal process open on both sides 34 times, on the right side 14 times, on the left side 8 times —*i. e.*, in 56 of 70 cases that were examined. Zuckerkandl found that the vaginal process was not obliterated at the fourth month in 37 of 100 cases examined, and in 6 of the cases a finger could be introduced, in 14 it was about 3 mm. (0.12 inch) in diameter, and in the others still smaller. Féré examined 188 children up to nine years of age. In 59 of the cases there was incomplete or total absence of any obliteration. In 19 the condition was bilateral, in 21 cases on the right side and in 19 on the left; 32 of the cases were one month or under, 6 were two to three months old, 11 between three and six months of age, and 10 over six months. Ramonede examined 215 young boys and adults, and found that 32 had a patent vaginal process, and that in 26 this structure was rudimentary. H. Sachs recommends that the data be subdivided into those under four months of age and those after this period because of the difference in the statistics:

	Up to four months.	Over four months.
Obliterated	41 per cent.	61 per cent.
Patent throughout	30 "	4 "
Patent above	29 "	29 "

All statistics show that the condition is more common on the right side, the proportion being about as 1.5 is to 1. This is generally explained by the fact that the testicle on the right side descends into the scrotum later than on the left side, and that the opening on the right side is usually larger. The above figures would seem to indicate that about half of the boys born have an open vaginal process, and are therefore predisposed to hernia. The conditions, however, in reality are not so grave because the opening is usually too small to be of much importance as far as hernia is concerned. The sac itself does not complete the hernia, as is shown by the cases in which a hernia develops suddenly during adult life, and on operation the sac is found to be congenital. There is, however, no doubt that the relation of the vaginal process explains the great frequency of oblique hernias in early childhood.

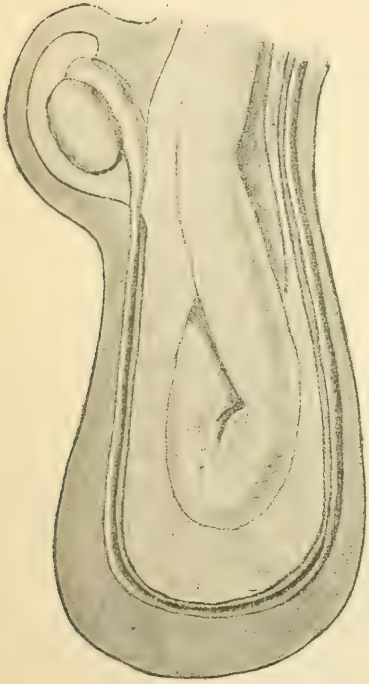
The most simple variety of congenital inguinal hernia is that in which the hernia passes immediately down to the fundus of the scrotum. There are, however, cases in which the hernial contents remain in the upper open portion—*i. e.*, in the funicular portion. Sometimes there remains in these cases a fine fistulous communication between the tunica vaginalis propria testis and the processus vaginalis above. This tract may allow fluid to trickle down from the abdominal cavity, while in other cases there remains a distinct fibrous cord indicating the obliterated portion of the vaginal process. These cases, of course, resemble clinically acquired inguinal hernia very closely, and on operation it may be very difficult for the surgeon to decide which condition he has to deal with.

The sac of a congenital hernia is oftentimes extremely thin and easily torn. It has a peculiar flaky appearance, for thin translucent parts alternate with thicker portions so that the appearance has been compared by Bayer with that of a checkerboard. The cord itself may form a distinct ridge on the inner side of the sac, or the individual parts of the cord are widely separated and the veins cover the entire external and posterior surface of the sac, whereas the vas deferens takes its course farthest back and by itself. Bayer considers this arrangement characteristic of congenital hernia. He also considers the absence of subserous fat and the presence of a continuous covering of cremaster fibres and undeveloped pillars further characteristics of congenital origin. The aponeurosis of the external oblique does not stop suddenly, but spreads out as a fine, veil-like membrane on the cremaster layer. Besides that there is the valve-like closing, especially in the region of the infundibulum. Sachs found in all congenital hernial sacs several smooth muscle-fibres in the lateral and posterior portions of the pars funicularis. These were so closely adherent to the serosa that they appeared as a portion of the wall, and he considered them to be remnants of the gubernaculum Hunteri.

Acquired Inguinal Hernia in Males.—This condition develops after the vaginal process has been closed. The peritoneum is forced into the fascia infundibulariformis and descends gradually along the cord into the scrotum. The hernia increases slowly in the early stages; only after the external ring has been passed does the size increase more rapidly. It is easy to distinguish this hernia from the congenital variety reaching to the testicle, but it is by no means easy to differentiate the condition from the funicular variety of congenital hernia. Even on operation one may not be able to decide whether the hernia is due to a fresh bulging of the peritoneum, or whether the hernial contents descend into an incompletely obliterated vaginal process. Inguinal hernia is most common in the first year of life, and it would be interesting to know whether this is largely due to incomplete obliteration of the vaginal process or not. Little is known regarding the relative frequency of congenital and acquired hernia. Eleven of 12 ruptures operated upon in Bergmann's clinic were congenital. Karewski found 5 congenital and 4 acquired hernias in 9 children operated

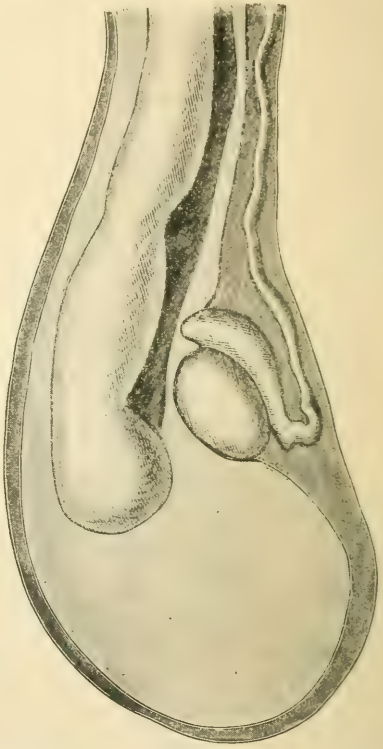
upon under two years of age. Bittner reports only 8 of 38 cases operated upon under ten years of age in which a communication with the processes vaginalis could be made out, but he emphasizes that the connection cannot be excluded in the numerous funicular hernias. Franck reports 18 congenital hernial sacs in 81 radical operations in adults; and Beresowsky in Kocher's clinic reports 43 congenital

Fig. 252.



Congenital inguinal hernia and partially descended testicle. Testicle inverted and the vas pulled down as a loop. (Terillon.)

Fig. 253.



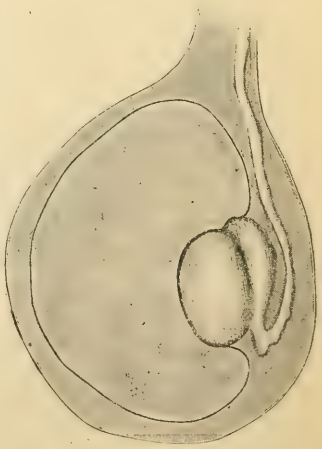
Hydrocele hernialis (congenital inguinal hernia with hydrocele of the common tunica).

hernias in 140 males operated upon. There were, however, many children included in these statistics. Personally the author has observed 9 congenital cases and 1 acquired case in 10 boys operated upon under five years.

Cryptorchismus, Hydrocele, and Hernia.—The testicle while descending may be arrested in various places. When it remains permanently in an abnormal position, the condition is spoken of as ectopia. It may remain stationary in its abnormal position or follow an abnormal course, so that ectopia intra-abdominalis (lumbalis, iliaca), ectopia inguinalis (interna, interstitialis, externa), and ectopia extra-abdominalis (pubica, genitocruralis, cruroscrotalis, perinealis) result.

If the testicle is not found on examination, the condition is spoken of as cryptorchids. The testicle may be found in the anterior wall of the tunica vaginalis, or it may be upside down, due to inversion in the course of its descent. Sometimes the testicle remains undescended, while the vas deferens descends, accompanied by a hernia, into the scrotum. (Fig. 252.) Should the testicle remain undescended or follow some faulty route, the inguinal canal usually remains wide open. The vaginal process is very apt to descend even when the testicle does not, but it is not large unless accompanied by a hernia. The most interesting cases are those of ectopia inguinalis. Sometimes a testicle in the inguinal region is extremely movable. It may be pushed down out of the external ring, but snaps back immediately. The ring itself is open, and it is not uncommon to have a hernia in front of the testicle in the large vaginal process. If the testicle becomes lost in the inguinal canal, hernial sacs may develop, some in the region of the abdominal wall, some outside in the scrotum (hour-glass variety). The accumulation of serous fluid in the remnant of the processus vaginalis peritonei is of practical significance. If the entire canal remains open, with a slight constriction at the mouth, fluid will collect in the cavity, and what is known as a hydrocele vaginalis communicans develops. If the opening is large, the sac will be distended with fluid on standing up, which will, however, go back into the peritoneal cavity again on lying down. If the communication between the abdominal cavity and the vaginal process is very small, this hydrocele will empty itself slowly, and the condition may be confounded with an inguinal hernia that is difficult to reduce, especially since the contents reappear after reduction. Nevertheless, the difficulties of diagnosis will as a rule not be very great, because a hernia is very apt to reappear rapidly on straining, while the fluid accumulated very slowly. If there is an accumulation of fluid in a patent vaginal process containing some abdominal organ, then the condition is known as a hydrocele hernialis. (Fig. 253.)

Fig. 254.

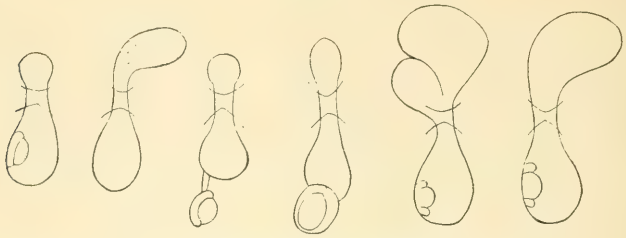


Hydrocele of the tunica vaginalis

Fluid may accumulate, however, when the vaginal process is completely obliterated above. The most simple variety is common hydrocele or hydrocele testiculi. These are especially common in childhood, although they also occur later. The tumor is oval, rounded off above and below, and may be pear-shaped with a pointed prolongation extending upward along the cord. If the swelling extends still farther upward, the condition will be known as a hydrocele testiculi et funiculi. The surface of a hydrocele is usually smooth and the mass fluctuates more or less

distinctly. If the condition is under more or less tension, it may not be possible to palpate the cord, the testicle, or the epididymis. The position of the testicle, however, will usually be evident from the peculiar resistance and the pain produced by pressure over this structure.

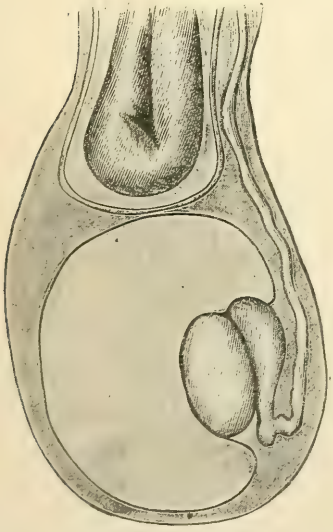
FIG. 255.



Different types of binocular hydrocele: *abd*, abdominal sac; *scr*, scrotal sac; *iL*, internal; *al*, external ring. (Kocher.)

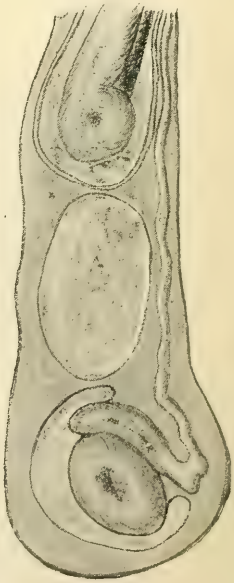
In 95 per cent. of the cases the testicle lies in the posterior portion corresponding to the normal position of the tunica propriæ. The tumor mass is rather heavy and is dull on percussion. Translucency is a

FIG. 256.



Hydrocele of the tunica vaginalis with acquired inguinal hernia.

FIG. 257.



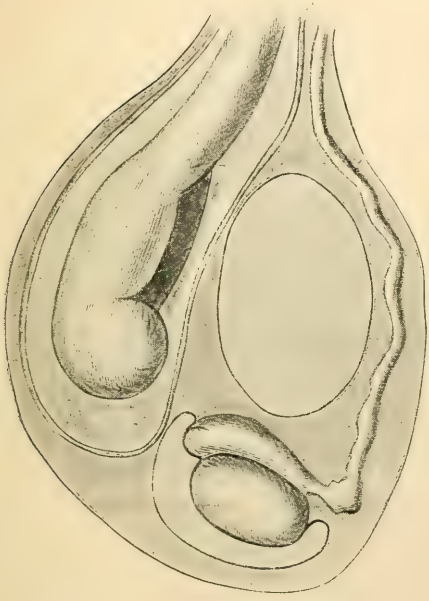
Hydrocele of the cord with acquired inguinal hernia.

valuable point, although this is not absolutely diagnostic of fluid, because in inguinal hernias of young children the same condition has been noted, and also in certain sarcomata.

The higher up the fluid extends, the greater the resemblance to an

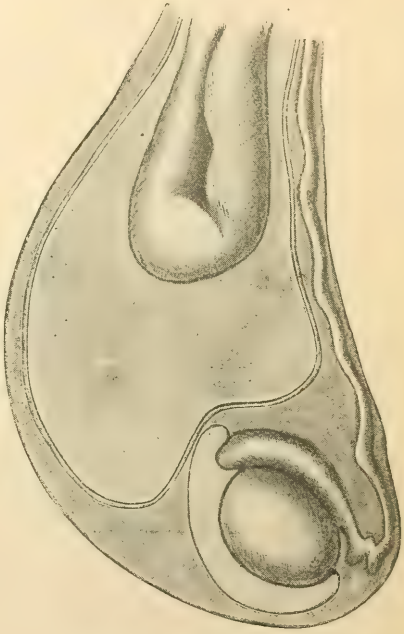
irreducible hernia. It has already been mentioned that there are cases with one or more sacs filled with fluid in the region of the cord, a condition known as hydrocele funiculi. Sometimes a hydrocele consists of several sacs that may communicate with one another through small openings, and cases occur in which the contents of one sac can be more or less completely expelled into the neighboring cavity. The higher up the upper sac reaches, the greater the resemblance between this hydrocele bilocularis and a hernia. There are cases in which the upper portion of the sac may be within the abdominal cavity. These are known as hydrocele bilocularis intra-abdominalis. The swelling passes along the cord into the abdominal cavity, and the contents may be more or less completely pushed back, but reappear on straining or when

FIG. 258.



Acquired inguinal hernia in front of the hydrocele of the cord.

FIG. 259.



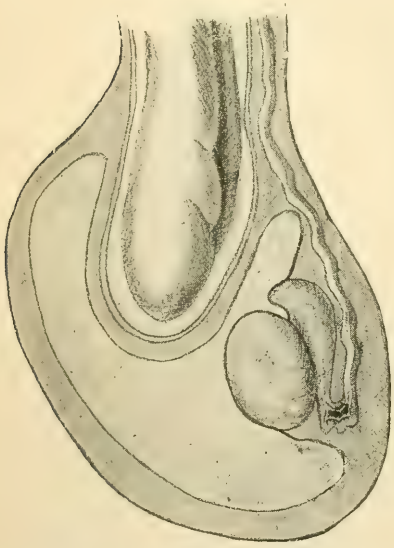
Acquired inguinal hernia with hydrocele of the sac.

pressure is brought to bear on the abdomen. It sometimes happens that the intra-abdominal sac is very large and lies in the iliac fossa or is found along the anterior abdominal wall as high up as the umbilicus. Superficial examination may lead one to confound this condition very readily with a hernia, but on pressing away the fluid one experiences a sensation as if the contents have been pressed into another closed space which offers more or less elastic resistance, unlike the condition when a hernia is replaced. Bimanual examination may sometimes detect the internal sac, and, besides this, the translucency which never exists in a large hernia in adults is of diagnostic importance. The clinical picture

may be difficult to interpret when there is a hernia combined with a hydrocele; for instance, a hydrocele funiculi with an ordinary oblique hernia, or a hydrocele with an inguinal hernia which more or less covers up the former condition. Figs. 257 to 260 illustrate the conditions possible.

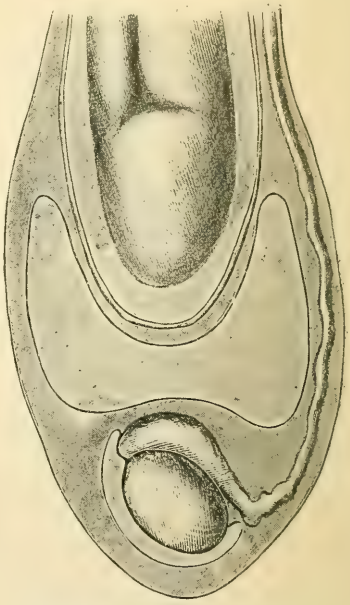
The situation is much more complicated when an inguinal hernia on descending becomes surrounded by an already existing hydrocele. This may be so complete that the hernial sac is surrounded almost entirely by a second serous layer. Cases of this sort were described first by Astley Cooper as encysted hernia. According to this author, this condition is most common in oblique congenital hernias, and is explained

FIG. 260.



Encysted hernia with invagination of a hydrocele of the tunica vaginalis.

FIG. 261.



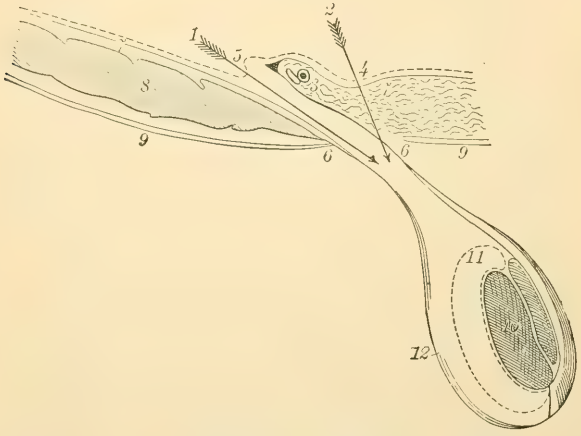
Encysted hernia with invagination of a hydrocele of the cord.

easiest by assuming that the vaginal process closes only in the region of the inguinal ring, but remains patent above and below. If a loop of intestine comes down in the upper portion, it may push the obliterated portion ahead, while on descending still farther the lower sac becomes invaginated. According to Kocher, hydrocele bilocularis may also lead to the development of an encysted hernia, especially if the hydrocele has been previously aspirated. The relaxed internal portion of the hydrocele is pressed upward by the abdominal pressure, while the abdominal viscera descend in the funnel-shaped bulging of the peritoneum. A case of this sort forms the intervening stage between a congenital and an acquired encysted hernia. (Figs. 260 and 261.) The diagnosis is readily made on examination. All that can be detected

is the simultaneous existence of a hydrocele and a hernia. On operation, one will be able to determine the exact condition. On opening the tense sac one will find a completely closed-off serous cavity into which a second sac projects from above, and only after opening the second sac does the surgeon come into contact with the hernia itself. If the hernial sac is congenital, the covering of the hydrocele ought to be continuous with the hernial sac, but even in an acquired hernia it may be extremely difficult to separate the sac from the wall of the hydrocele.

Direct Inguinal Hernia.—The internal inguinal fossa lies internal to the plica epigastrica. The abdominal cavity is closed off here by the fascia transversalis, fibres of the aponeurosis of the external oblique, and by masses of connective tissue. The gap is closed below

FIG. 262.



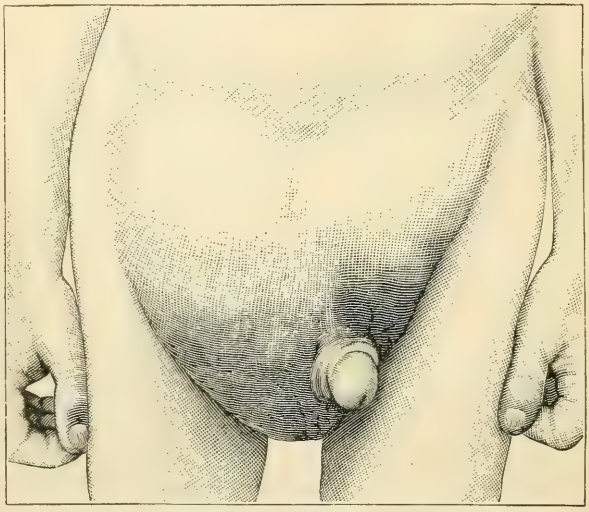
Showing an oblique and a direct hernia: 1, oblique hernia; 2, direct hernia; 3, epigastric artery; 4, internal inguinal fossa; 5, external inguinal fossa; 6, external inguinal ring; 7, intra-abdominal fascia; 8, internal oblique muscle and transversalis; 9, aponeurosis of the external oblique; 10, testicle; 11, tunica vaginalis propria; 12, tunica vaginalis communis.

by Poupart's ligament, above by the free margin of the internal oblique and transversalis, to the inner side by the fibres of the ligamentum collesii in connection with the sheath of the rectus. It is easily seen that the abdominal wall is weak in this region, because in individuals well advanced in years there is always some bulging of the peritoneum in this region, and the fossa is usually deeper than the external inguinal fossa at this time of life. The external inguinal fossa is due to the descent of the testicle, while the internal one is essentially the result of intra-abdominal pressure upon a weak spot in the abdominal wall. The cases of hernia are the result of gradual stretching and bulging in this region, usually after the fortieth year of life, and especially in people whose general resistance, particularly that of the abdominal wall, has become lowered, while they are exposed to influences that tax the abdominal wall more severely. Not infrequently the hernias are bilateral, but may not be developed to an equal degree. The hernia

leaves the abdominal cavity through the inner inguinal fossa—*i. e.*, to the inner side of the deep epigastric artery—and appears in the region of the external abdominal ring, therefore in the same place as do oblique hernias. The internal inguinal fossa is almost exactly behind the external abdominal ring, so that the course is very straight, which has given rise to the name.

The sac is covered only by the intra-abdominal fascia, the external fascia, and the skin, although the first layer is not constant, because it sometimes happens that the sac finds its way through a slit and pushes the fibres of this layer to one side. The direct hernia is frequently round, and when it increases considerably in size it tends to stay in the vicinity of Poupart's ligament and expand toward the median line.

Fig. 263.



Bilateral direct inguinal hernia.

This point is of differential diagnostic importance, because oblique hernias usually enlarge downward into the scrotum. If an inguinal hernia is larger than a man's fist and does not extend into the scrotum, it is very liable to be a direct hernia. Sometimes, however, it enlarges downward into the scrotum, but is not intimately connected with the cord and testicle, for it is always easy to separate these structures. Generally the cord is to the outer side of the hernia, although sometimes it is found behind. It does not bear any relation to the tunica vaginalis communis of the cord and testicle, so that even when the hernia is well down in the scrotum there is usually an appreciable space between it and the testicle. Direct hernias do not show the same tendency to enlarge as do oblique hernias, although some of them are extremely large; usually, however, they are about the size of a hen's egg. In bilateral large direct hernias the inner margins are in direct contact, as shown in Fig. 263. Hernias of this sort develop very

slowly and the hernial ring enlarges gradually so that strangulation is comparatively uncommon. There is no particular difference between the sexes, and the small intestine or omentum is generally found in the sac, although the bladder is not infrequently present.

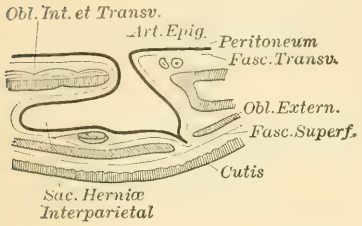
Inguinal Hernias in Females.—Generally speaking, the processus vaginalis is smaller and closes sooner in girls than in boys. Sometimes it remains open, however, and Féré reports 17 cases in 158 children examined three years of age or under. Zuckerkandl reports 3 bilateral cases and 1 left-sided case in 19 children. Sachs found an open canal 38 times in 150 newborn infants. In boys the proportion of the cases found open diminishes up to the third year, while in girls there is no particular difference between the first and third year. It is therefore probable that the vaginal process shows less tendency to close after birth in girls than in boys. Inguinal hernia in the early years of life is uncommon in females, and it is much more difficult in girls to determine whether the hernia is congenital or acquired. Even on operation there may be nothing more than a noticeably close connection between the sac and the round ligament, or perhaps constrictions of the sac such as were described in connection with males. Microscopical examination has proved the presence of smooth muscle-fibres from the internal cremaster layer on the diverticulum of Nuck. It would seem as if the persistence of this diverticulum favored the development of inguinal hernia later, for Verger found a congenital predisposition 15 times in 23 operations. After the twenty-fifth year of life inguinal hernia becomes somewhat more common, due especially to pregnancy. Of 978 women with inguinal hernia, 772 had had one or more children.

When an oblique hernia increases in size in females, it comes down into the labium majora, and the same grades are observed as in males, therefore incipiens, incompleta, completa, labialis anterior. Generally speaking, inguinal hernia in females shows no great tendency to increase, but is apt to remain stationary for a considerable length of time. Sometimes, however, it becomes extremely large and may extend as far as the knees. The overlying layers are not so dense as in scrotal hernias, and at times the contour of the loops of intestine can be easily seen. If the external ring is very large and the pillars very lax, the hernia may descend on the thigh and be confounded with a femoral hernia. This error will be detected by passing the finger into the inguinal canal after reducing the hernia. Inguinal rupture develops much more slowly in females than in males, and as a rule causes no pain, and there is little tendency for strangulation to occur.

Hydrocele, due to incomplete obliteration of the canal of Nuck, is sometimes observed, and forms a complication in hernia. Sometimes a small hernia lies behind the hydrocele, and encysted hernias have also been reported. Hour-glass hernias and inguino-subperitoneal hernias are extremely uncommon. In women inguinal varieties are much more common than any other, although less common than in men. Berger found that of 2534 women with hernia, 1123 were inguinal—*i. e.*, 44.3

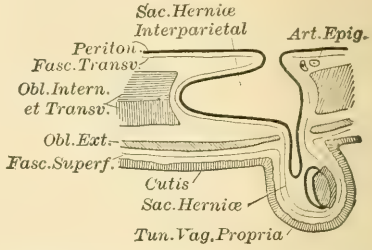
per cent.; and the right side was more affected than the left. The same principles apply, as far as treatment is concerned, as in males; but the radical operation is easier and more apt to be successful because the conditions are not complicated by the presence of a cord. Trusses and appliances are apt to be ineffective. It is extremely difficult clinically to distinguish direct hernias from oblique in females, and this is of little importance as far as the treatment is concerned.

FIG. 264.



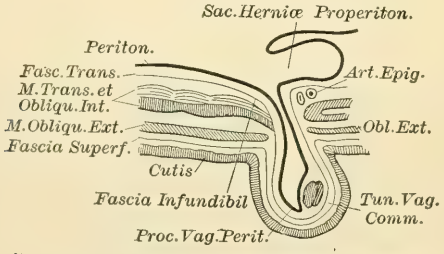
Interparietal inguinal hernia between the internal and external oblique. (Göbell.)

FIG. 265.



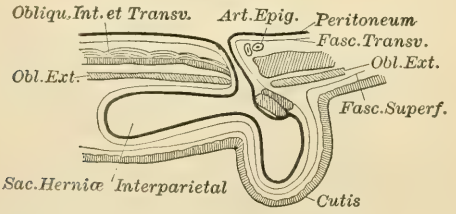
Interstitial inguinal hernia between the external oblique and fascia transversalis. (Göbell.)

FIG. 266.



Inguinoproperitoneal antevesical hernia, bilocular and congenital. (Göbell.)

FIG. 267.

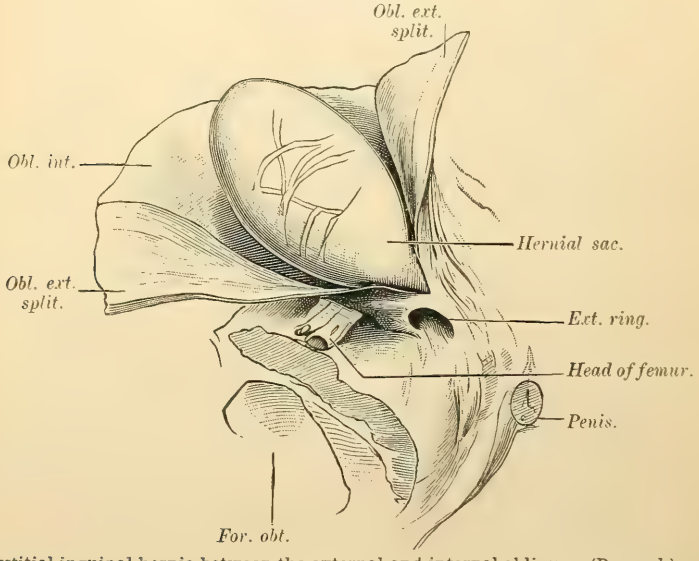


Superficial inguinal hernia between the external oblique and superficial fascia. (Göbell.)

Varieties of Inguinal Hernia.—Cases have been reported in which a hernia came down through the fossa lying between the bladder and the plica vesico-umbilicalis. These hernias take an oblique course and appear either in the region of the external ring or still farther out. Berger reports 4 cases of this sort, 3 of which contained the bladder. There is also a para-inguinal variety in which the canal runs parallel to

the inguinal canal, although the site of exit has nothing to do with the inguinal rings proper. Tuffier reports a case of this sort in which the hernial canal was to the inner side of the inguinal canal. Bornemann found on autopsy that a large left-sided hernia was possessed of a diverticulum that passed beneath the suspensory ligament of the penis and entered the right side of the scrotum. Certain other cases have been reported in which the hernial sac was entirely within the abdominal wall. These cases are quite frequently associated with an ordinary inguinal hernia, and may have a common neck or two separate openings. The cases in which the sac is in the region of the abdominal wall may be called interstitial or interparietal, and as it is sometimes feasible to determine whether the hernia consists of one or more sacs, they are subdivided into monocular and bilocular. Macready reports 169 cases of interparietal hernia, and Göbell has collected 280 cases and illustrated them as shown in Figs. 264–267. These cases are usually detected when there is some strangulation present, so that it is difficult to investigate the exact conditions. Surgeons apply the term interparietal to those cases in which the sac lies between the layers of the abdominal wall: therefore in the loose connective tissue between the peritoneum and fascia transversalis; secondly, between the internal oblique and external oblique; and, finally, in the loose connective tissue beneath the skin.

FIG. 268.



Interstitial inguinal hernia between the external and internal oblique. (Rumpel.)

Surgeons distinguish three varieties of interparietal hernia of the inguinal region. In the strict sense of the word they may be monocular or bilocular, and may be partly or entirely in the region of the abdominal muscles. They are usually found in the space between the internal oblique and aponeurosis of the external oblique. When they

become of considerable size, the internal oblique and transversalis become so atrophied that nothing is to be found behind the hernia but the fascia transversalis, although in other cases the internal oblique will be found quite intact. Göbell distinguishes several varieties, and lays stress upon whether they extend toward the median line or laterally. According to this author, there are those between the internal and external oblique, those between the internal oblique and transversalis, and those between the transversalis and fascia transversalis. Of 115 cases collected by Göbell, 111 were in males and 4 in females, and they were twice as common on the right side. More than half the cases were in cryptorchids, so that in a majority of the cases there were congenital errors of development favoring hernia. Certain of the cases, however, are due to awkward attempts at taxis, reduction *en bloc*, improper bandages, trusses, etc. The second variety includes the properitoneal hernias, studied especially by Krönlein. This author reports 23 cases. Hölder and Breiter collected 40, and Göbell 6; and 67 of these cases were in males and only 2 in females, while 37 were on the right side and 23 on the left side; of the cases, 60 were bilocular (inguinoproperitoneal). In more than half of the cases cryptorchismus was found, and in 39 the accompanying inguinal hernia was congenital. In individual cases the properitoneal hernias may have been due to repeated awkward attempts at reduction, but the vast majority are beyond doubt congenital.

A third variety includes the cases in which the sac is outside of the muscles of the abdominal wall, but under the skin of the abdomen, and not in the scrotum or labia. Küster applies the name "inguinosuperficialis" to this group. They are always congenital and are associated with ectopia of an atrophied testicle. The hernia is covered only by the skin and superficial fascia. There is no cremaster or tunica vaginalis communis. The hernial ring is very wide and the external and internal rings are directly superimposed. It is not uncommon in interparietal and properitoneal hernias to find some abnormality in the region of the inguinal ring. The external ring is frequently small or completely closed. This condition has been considered to be the obstruction to the descent of the testicles, and it has been claimed that on account of this obstruction the processus vaginalis spreads out behind the ring in the abdominal wall. (Tillaux.)

M. Schmidt, while operating upon a strangulated interparietal hernia, found the internal ring displaced upward and outward toward the anterior superior spine, a condition which, considering the details of the case, was in all probability congenital. The external ring was in its normal position, so that the inguinal canal was much longer than normal, and the testicle would have had to travel considerably farther to reach its normal position a fact which explains how it is that many of these cases are cryptorchids, and that the vaginal process lies within the abdominal wall. Schmidt assumes that congenital displacement of the internal ring is due to displacement of the gubernaculum Hunteri, an anomaly that has recently been observed in

females by Berger. Schmidt assumes that the common opening of bilocular inguinoproperitoneal hernias is not pathological, but simply due to lateral displacement of the internal ring, which would mean that in these cases the internal sac would have to be considered interparietal and not properitoneal.

Treatment.—The radical treatment has been considered in a preceding chapter. In young children a suitable truss should be fitted and worn until the hernia is cured. This is a difficult task, but can be done if sufficient attention is given. It is best to have two trusses that may be worn alternately, and they should be covered with some protective. The skin should be carefully attended to, but powders are to be avoided. Salves on small pieces of cotton are sometimes of value. It is best to use raw wool or raw cotton because this does not absorb water so readily. For safety' sake the truss should be worn day and night, because if the hernia comes down once, all the progress of several weeks may be for naught. The earlier treatment commences, the quicker the result, and in simple cases a cure is possible in from four to six weeks, although one should not be too hasty in discarding the truss. The nutrition of the child should be carefully attended to, because a well-developed panniculus adiposus favors recovery, and sometimes the hernia disappears under these conditions even without any appliance. French trusses with a fixed pad are generally used. The pad itself should be oval, and should extend somewhat beyond the margin of the ring on all sides. The thickness of the pad will depend upon the fat contained in the abdominal wall. The thinner the patient, the flatter the pad. The position of the pad should correspond to the plane of the hernial opening. It is quite common to have the lower margin directed inward too much, which allows the upper margin to stand off, so that the position of the pad must be carefully regulated according to the anatomical conditions in the individual case. This pad should press only upon the soft parts. It is inadvisable to use the pubes as a point of support, so as to be able to increase the pressure, because it causes such pain that the patients begin to handle the truss and misplace it, which, of course, renders the appliance practically useless. Pressure upon the cord may also do damage. Cooper called attention to the fact that pressure should be brought to bear not only upon the external ring, but also upon the entire inguinal canal, especially in the region of the internal ring, so as to press the anterior and posterior walls together. Most trusses cannot be applied in this way, for the thickest portion of the pad comes about in the middle of the external ring, and the lateral portion of the inguinal canal, as pointed out by Hack, remains open.

Trusses have been modified by Hack and Wolfermann so as to overcome as much as possible the disadvantages of this method of treatment. Recent modifications have been made by Löwy which seem to have improved the pads considerably.

With large scrotal hernias an attempt is usually made by the instrument-maker to prevent the hernia from coming down by the use of a

triangular pad, one corner of which rests upon the pubes. The pad prevents the hernia from entering the scrotum to be sure, but crowds it upward on the abdominal wall, so that the pad has to be made larger and larger although it does not improve the condition. Macready's rat-tail truss seems to have overcome this difficulty somewhat, because it not only blocks the way into the scrotum, but closes the upper portion of the canal and hernial ring as well. Hoffa has recently described a truss for which he claims a great deal; the apparatus is somewhat complicated. In difficult cases one should not be discouraged too soon, but replace the hernia again and again if it should happen to come down. The truss should be applied day and night, and the patient kept recumbent if necessary. It will be noticed that a rebellious hernia in time shows less and less tendency to come down, and finally ceases to do so. In certain cases of very large inguinal hernia all attempts to keep it back are futile, and in these desperate cases it is oftentimes a kindness to cease any attempts to reduce the hernia permanently, and to apply some suspensory which is so arranged that a certain amount of pressure is brought to bear upon the hernia. It may be necessary in cases of this sort to wear shoulder-straps, because the pelvic band does not sufficient support. In this way any sudden increase in the size of the hernia is prevented, and not infrequently the rupture diminishes in size little by little, so that finally a truss may be fitted that keeps the hernia back permanently. The same appliance should be used with irreducible hernias. If the sac contains only omentum, then a truss may be used with a hollow pad, because the omentum stands the pressure well, but no pressure should be made upon intestine. Kingdon's hinged cup is an appliance that meets these demands; and in desperate cases the metal springs with pads, recommended by Deupre and Prevost, may be applied.

Strangulated inguinal hernia and the radical operation have already been considered.

FEMORAL HERNIA.

The fossæ in the vicinity of Poupart's ligament have already been considered. Directly beneath this structure, just below the internal inguinal fossa, between Poupart's ligament and the ramus of the pubes, there is a small depression, called the femoral fossa, which is the region where a femoral hernia leaves the abdominal cavity. These ruptures follow along the femoral vessels and appear in the thigh. This tract is of considerable length, and has therefore been called the crural or femoral canal, and the openings the internal and external femoral rings. This name is not correct, strictly speaking, because every individual does not have a canal of this sort; only those who are afflicted with hernia.

The space between the anterior superior spine and the spine of the pubes is bridged over by the ligament, and is called the arcus cruralis. The insertion of the ligament to the pubes is broad and spreads out over the bone. Some of the fibres pass backward, cover the angle

between the pubes and Poupart's ligament, and have a free concave edge externally. This layer of fibrous tissue is called "Gimbernat's ligament."

Fig. 269.

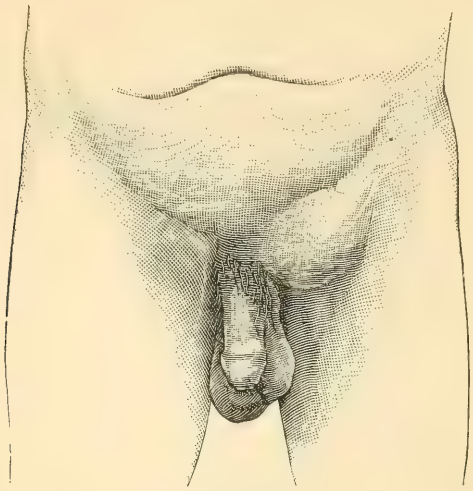


Fig. 270.

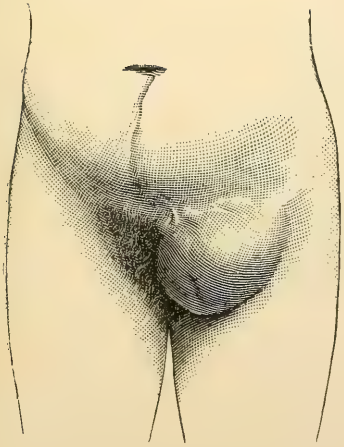
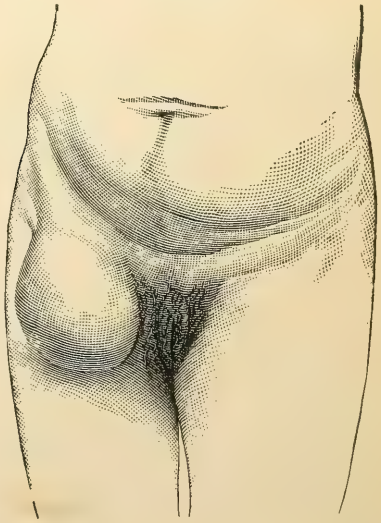


Fig. 271.

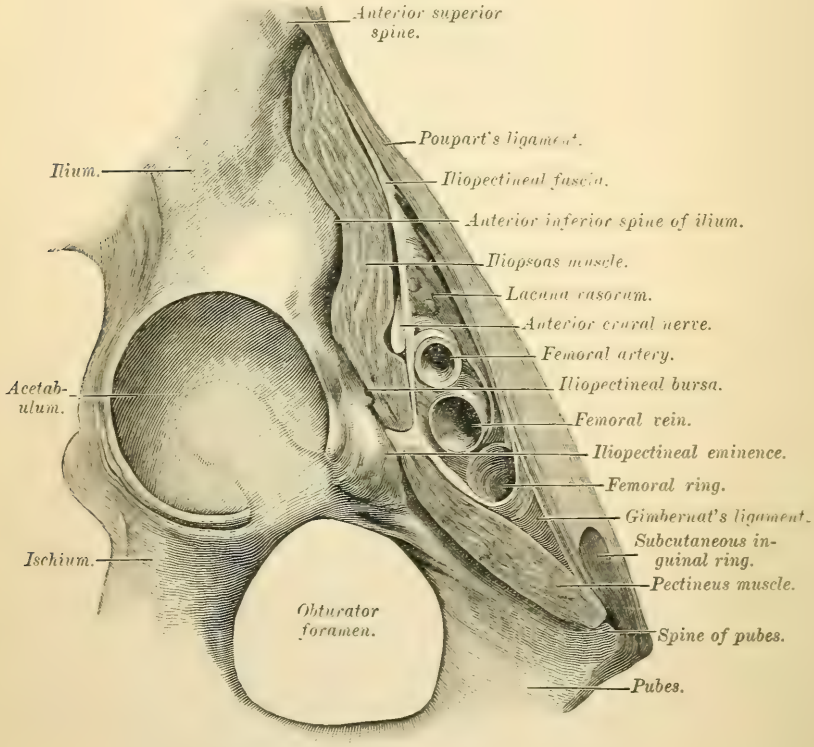


A fold of fascia passes downward from Poupart's ligament to the iliopectineal eminence, thus dividing the space into two parts, a lateral compartment for the muscles and a median compartment for the vessels.

The iliopsoas leaves the pelvis through the outer compartment and is inserted into the lesser trochanter. The anterior crural nerve also passes through the same space, while the median compartment contains from without inward the femoral artery and femoral vein, both surrounded by a sheath, which in turn is subdivided by a septum passing between the artery and the vein.

Between the vein and Gimbernat's ligament there remains a space which differs in size in different individuals. Generally speaking, this space is broader the broader the pelvis, and is therefore larger in females than in males. Its size also depends somewhat upon the development

FIG. 272.

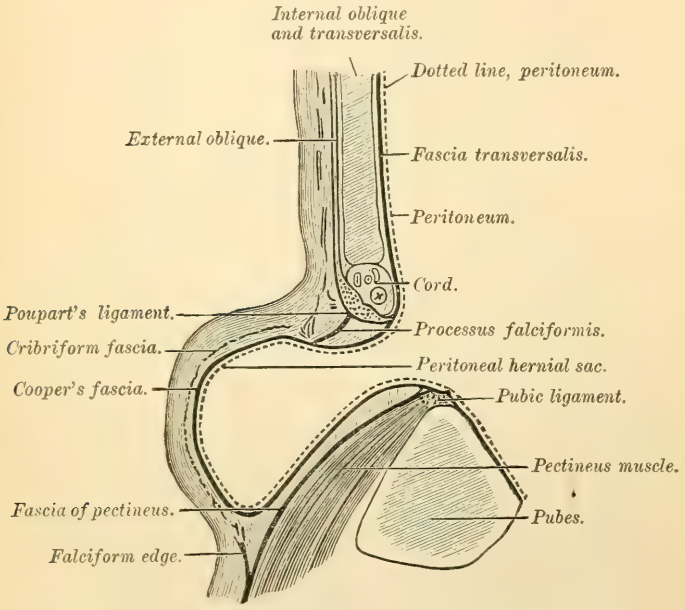


Section through the arcus cruralis. (Spalteholz.)

of Gimbernat's ligament. Generally this region is filled by a lymph-gland (Rosenmüller), but aside from this the abdominal wall is very thin in this region. The fascia transversalis is extremely thin between Poupart's ligament and the ramus of the pubes, and has been called by Cloquet the septum crurale. If this structure is removed, a finger can be passed into the space between the sheath of the vessel and Gimbernat's ligament, and this region is called the internal femoral ring. Its borders are above Poupart's ligament, externally the sheath of the

vessels, below the thickened periosteum of the pubes (ligamentum pubicum Cooperi), and internally Gimbernat's ligament. If the lymph-gland mentioned is pushed outward in front of the finger, one will reach the surface of the thigh through an oval opening in the fascia lata. This opening is bounded on the outer side by the falciform edge of the iliac fascia, and the vessels are covered by this structure except for a small portion of the vein where the internal saphenous enters the femoral. This opening is covered by a certain amount of fat, which is bound down to the lower margin by the deep layer of the superficial fascia and contains numerous small lymph-glands and vessels. This

FIG. 273.



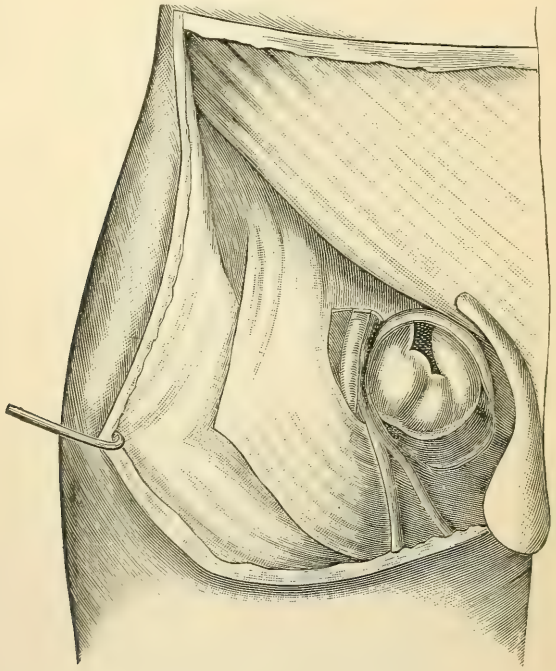
Diagrammatic section through a femoral hernia and inguinal canal.

layer of fascia is called the cribriform fascia. The fossa beneath is produced by the small gap left between the muscles that leave the pelvis and those on the front of the thigh. The triangle in which this opening is contained is called "Scarpa's triangle," which is bounded externally by the sartorius and internally by the adductor longus. The deeper seated smaller subinguinal triangle is bounded externally by the iliopsoas and internally by the pectineus, and the base of both triangles is formed by Poupart's ligament. The muscles are surrounded with fascia which is inserted into the bone, and the vessels surrounded by their sheath pass downward through this region to Hunter's canal. The weak spot in the inner side of the abdominal wall is the region where a femoral hernia leaves the body cavity, so that a rupture in this region is bounded externally by the sheath of the vessels, internally by Gim-

bernat's ligament, and is covered below by the cribriform fascia as it passes to the surface through the saphenous opening of the fascia lata.

A typical case would be covered by the external skin, the cribriform fascia, the intra-abdominal fascia, the subperitoneal fat, and finally by the peritoneal hernial sac. In the majority of cases it would be difficult to distinguish these layers, and when operating upon femoral hernia one should be prepared to see the intestine immediately after dividing the skin. In some of the cases the layers of tissue are much thinned, while in others the hernia does not push the structures ahead of it, but distends some breach more and more. There

FIG. 274.



Typical small femoral hernia with fascia lata and skin retracted. (Le Fort.)

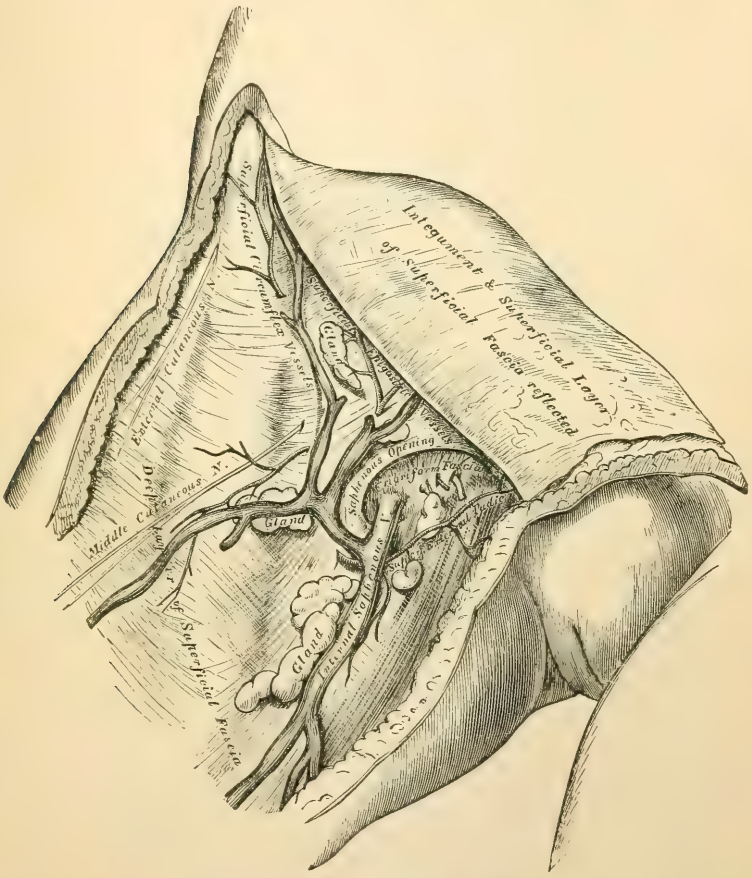
may be no fascia propria hernia and the cribriform fascia may be absent, so that the sac is quite intimately adherent to the skin. In old femoral hernias a well-defined mass of fat is sometimes found intimately adherent to the sac, and not infrequently there will be present a small bursa produced by the pressure of trusses. Generally a femoral hernia tends to expand upward rather than downward, because in this region the cribriform fascia is less adherent to the margin of the saphenous opening.

The relation of the vessels to a femoral hernia is important. The usual arrangement is to have the artery give off the deep epigastric immediately beneath Poupart's ligament, while the superficial epigas-

tric comes off just outside. Both of these vessels, as well as the femoral vessels, are to the outer side of the canal. The obturator artery arises from the anterior trunk of the internal iliac, and passes along the brim of the pelvis to the obturator canal, and therefore does not come into relation with a femoral hernia.

Anomalies are not uncommon. The deep epigastric may arise from the iliac artery and pass along Poupart's ligament and along the upper

FIG. 275.

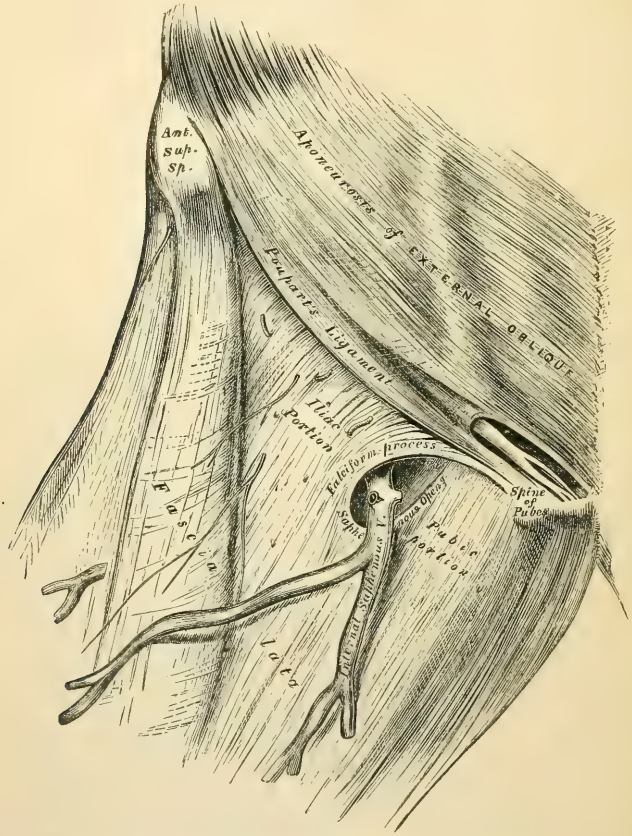


Femoral hernia. Superficial dissection. (Gray.)

margin of the femoral ring. A communicating branch not infrequently passes from the deep epigastric along the outer margin of the femoral ring to the obturator artery. The obturator itself may arise from the femoral and pass along the outer side of the femoral ring to the obturator opening, and this artery may come off of the femoral artery in common with the deep epigastric; and when this trunk is short, the obturator passes downward to the other side of the femoral ring, and

when this trunk is longer, the obturator artery may pass along the upper margin of the femoral ring, and then downward internal to the ring on Gimbernat's ligament to the obturator canal, so that in these cases the ring is surrounded by vessels that may be injured during operation. This anomaly is rare, and has been termed by Hesselbach the "fatal circle." Cloquet found this condition in 125 males to be bilateral 21 times; and unilateral 14 times; whereas in females it was bilateral 35 times and unilateral 13 times.

FIG. 276.



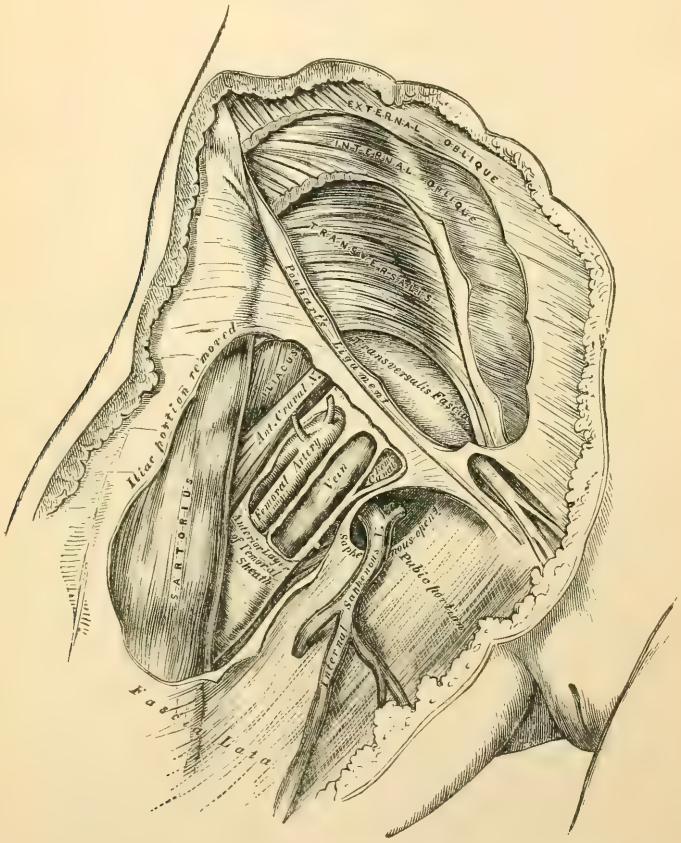
Femoral hernia, showing fascia lata and saphenous opening. (Gray.)

If a femoral hernia has come down as far as the saphenous opening, it endeavors to find its way out by stretching or rupturing the cribriform fascia. When this is not possible, it turns upward toward Poupart's ligament, and resembles an inguinal hernia, but is stopped at this band. Usually the hernia has a broad base, although rarely it may be more or less pendulous and may reach as far as the knees. Femoral hernia is much more common in females than in males, although inguinal hernia in females is more common than femoral

hernia. Berger found femoral hernia present in 32.7 per cent. of the cases, and inguinal hernia in 44.3 per cent. in women, and in men in 5.6 per cent. a femoral hernia and in 96 per cent. an inguinal hernia, some of which were associated with a femoral hernia. Of 831 cases of femoral hernia, 506 were simple, 335 on the right side, 171 on the left side, 215 bilateral, and the rest were associated with other hernias.

Varieties.—The hernia may take place through a gap in Gimbernat's ligament, so that it is completely surrounded by fibres of this

FIG. 277.



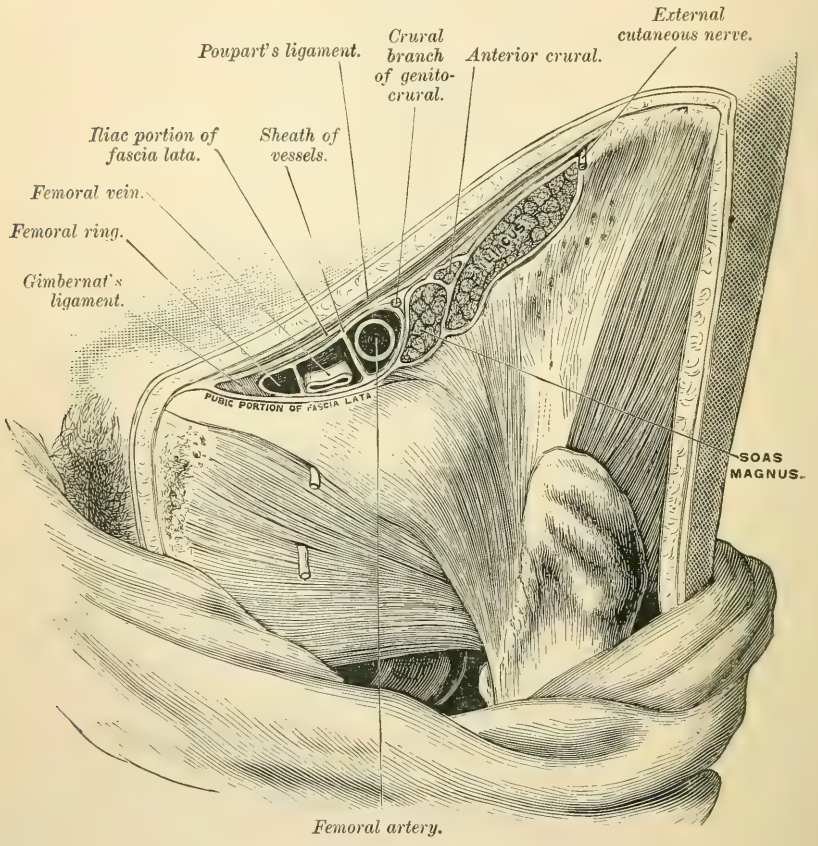
Femoral hernia. Iliac portion of fascia lata removed, and sheath of femoral vessels and femoral canal exposed. (Gray.)

structure. In certain of the cases the point of exit was internal to the lateral vesico-umbilical fold (hernia ligamente Gimbernatè of Laugier). In other cases the hernia enters the inner femoral ring, but soon burrows downward through the pectineal fascia, and may even burrow into the muscle-substance, and then lies almost as deep as an obturator hernia (hernia cruralis pectinea of Cloquet). The author has recently seen a femoral hernia which had a sac given off from the

main portion of the hernia at the level of Gimbernat's ligament. This extended downward on the pectineus for about 12 cm. (4.5 inches), but outside of the pectineal fascia.

Hernia cruralis externa, as described by A. K. Hesselbach, is found especially in individuals with a broad pelvis. It commences in the region of Poupart's ligament and extends downward in a conical manner, the base being quite broad. The tumor is very flat, because it lies beneath the fascia, and is covered besides by the muscular fascia,

FIG. 278.

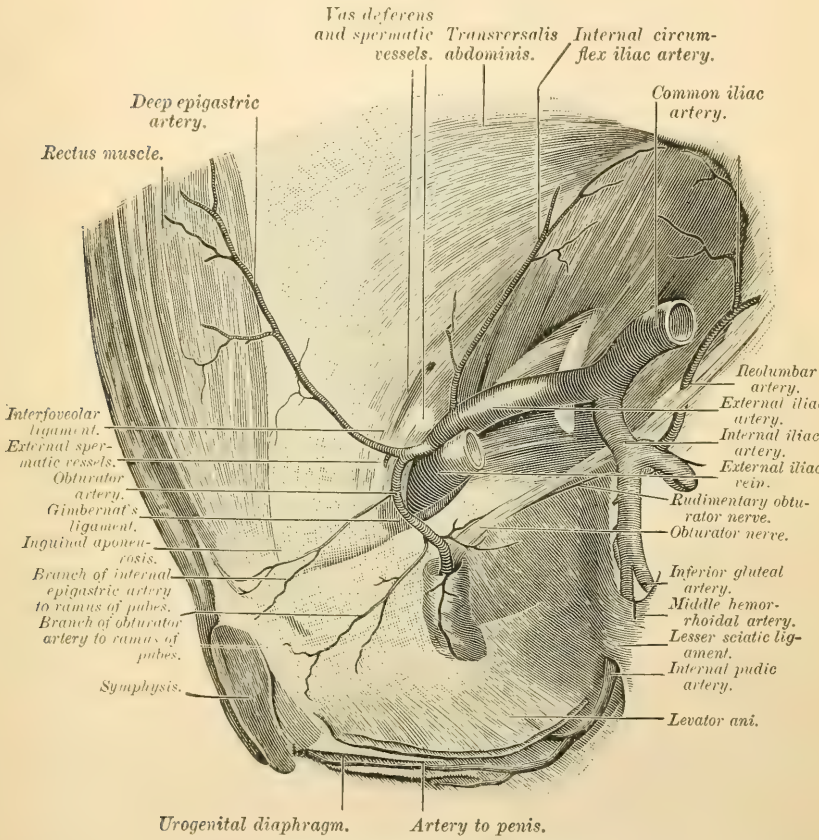


Structures which pass beneath the crural arch. (Gray.)

the fascia lata, and iliac fascia. Bähr reports 3 cases that developed after an injury in the region of the hip. Narath reports another variety of hernia externa that appeared after operations for congenital dislocations of the hip. He reports 6 cases in children between seven and eleven years of age, in which a peculiar hernia appeared on standing and straining, which disappeared, however, on lying down. This hernia had a broad base in the region of Poupart's ligament, and was flat and conical. The base was about 5 to 7 cm. (2 to 2.75 inches)

broad, and the hernia itself extended downward for about 4 cm. (1.5 inches). The amount of swelling was slight, and the hernial ring itself was so narrow that a finger could not be introduced. According to Narath's explanation, this hernia descends in the prolongation of the fascia transversalis in front of the large vessels, and the base is made up by the space between Poupart's ligament and the vessels and Gimbernat's ligament, and the line of union between the iliac fascia and

FIG. 279.



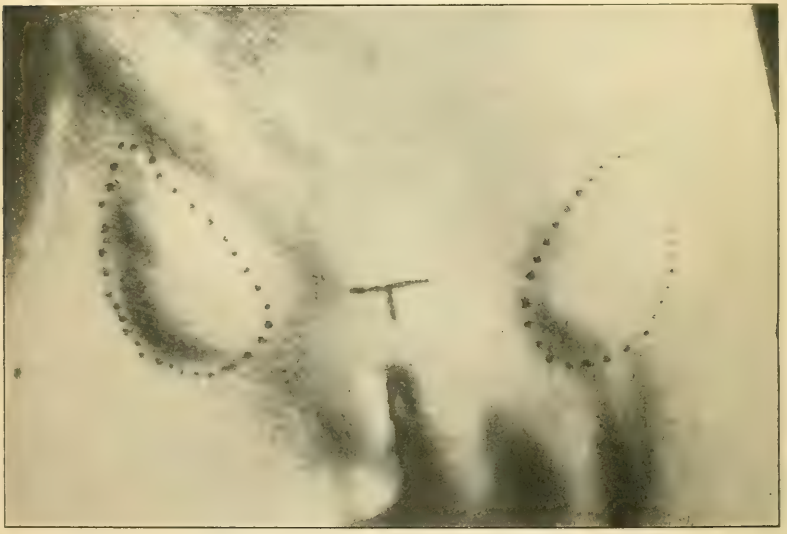
Abnormal obturator artery coming from a common trunk with the deep epigastric. (Fatal circle.) (Spalteholz.)

Poupart's ligament externally. These hernias are due to some force which pulls to one side the muscles and the sheath of the vessels adherent to their fascia. This is done by the traction on the leg, the abdomen, the kneading, and pressing upon the abductor attachment, which not infrequently causes slight tears, as well as by approximation of the points of insertion of the iliopsoas and pectineus which relaxes these muscles. Furthermore, these structures become atrophic because of the prolonged immobilization.

In hernia cruralis retrovascularis the sac lies behind the vessels and follows the sheath downward; and in hernia cruroperitonealis the sac, after passing through the internal femoral ring, consists of two portions: one of which follows the usual course, while the other, which is frequently larger, passes downward between the peritoneum and the fascia of the pelvis to the region of the obturator foramen. Breiter reports 9 cases of this sort, and A. Langer reports 1 case in a man, the former being in women. Terrier reports a case of hernia in which the sac consisted of three divisions: a properitoneal, a femoral portion, and one portion in the labium.

Femoral hernia is liable to remain unrecognized for a considerable length of time, because the condition does not produce any swelling on account of the deep position of the hernial ring. The symptoms of which the patients complain are indefinite, and do not lead even an experienced physician to suspect a hernia. The abdomen is frequently not examined in this region, so that the patients continue to have

FIG. 280.



Crural hernia following reduction of congenitally dislocated femurs. (Narath.)

symptoms and are subjected to all sorts of treatment. Finally some physician detects a small hernia that disappears on the slightest pressure. Sometimes a truss will hold these cases perfectly, although the conditions in this region are very unfavorable for the use of any mechanical appliance. The pad becomes unavoidably displaced because of the motion of the thigh, and it is not possible to apply pressure in the direction most favorable for closing the opening. The pad itself must be narrow in a femoral hernial, must be well padded, and held in place by an additional strap passing around the thigh. Special appliances of this sort have been constructed by Löwi. When a hernia is

very difficult to hold back, a large triangular pad in Scarpa's triangle may be serviceable. This may be held in place by straps passing around the thigh. Macready and Berger have paid particular attention to this subject. It is not uncommon to have a femoral hernia heal after wearing a truss.

Strangulation of Femoral Hernia.—A femoral hernia becomes strangulated rather often, compared with an inguinal hernia. Bryant found that of 94 cases of strangulation, 50 were inguinal hernias and 44 femoral hernias. Gosselin found the proportion to be as 113 is to 104, and Maydl as 159 is to 132; while Henggeler reports 111 strangulated inguinal hernias and 159 femoral hernias.

There has been considerable discussion as to the exact seat of the strangulation. The internal femoral ring, the margin of Gimbernat's ligament, the margin of the saphenous opening, the meshes of the cribriform fascia, and irregularities in the hernial sac, have all been held responsible, and there is no doubt that strangulation may occur in these places. In all probability the constriction takes place in the region of Gimbernat's ligament and at the saphenous opening. Bassini took a plaster cast of the femoral canal, and showed that the narrowest point was opposite the point of entrance of the saphenous vein. It is certain that the neck of the sac itself in femoral hernia is rarely the cause of strangulation. As far as the subsequent course is concerned, it is well known that the constriction taking place in this long, narrow canal may within a short time produce gangrene, and that the wall of the intestine is not infrequently strangulated. Other authors claim, especially Gosselin, that the early symptoms of strangulation in femoral hernia may be comparatively slight, so that one is much surprised on operation to find an already gangrenous intestine.

There seems to be no doubt that there is little reason to expect a favorable result from taxis in femoral hernias, not only because the desired effect is not obtained, but also because there is very frequently considerable disturbance of the intestine which renders it unwise to reduce the rupture. For this reason one should advise against taxis and favor radical operation. The incision is best made along the inner margin of the femoral vein. This opening should be made very carefully, because the sac not infrequently lies immediately beneath the skin, and if possible one should avoid injuring the internal saphenous vein. As a rule it is easier to separate the sac than in femoral hernia, because this structure is not liable to be very adherent to neighboring organs. In certain cases, however, it may be necessary to remove the overlying masses of fat and lymph-glands as well as hernial cysts that are sometimes observed in this region.

When there is reason to suppose that the intestine may be gangrenous, one should be extremely careful not to allow the intestine to slip back into the abdominal cavity. If it is possible to examine the loop of intestine thoroughly, then one may facilitate the reduction by nicking the hernial ring with a blunt bistoury, taking care not to

cut outward because of the femoral vein. As a rule it is best to cut inward toward Gimbernat's ligament, and it is advisable to make several small nicks instead of one large cut, so as to avoid injuring any abnormal vessels in the vicinity. Generally it is not necessary to divide the structures so completely that these vessels are in danger, and as it has always been inadvisable to operate in the dark, one should divide all tense bands from without inward after ligating any vessels that are liable to give trouble. In this way one also avoids damage to the intestine. If the appearance of the loop of intestine and the cloudy foul-smelling hernial fluid give rise to the suspicion that a portion of the gut is gangrenous, the author prefers to carry the incision upward over Poupart's ligament, and to divide this structure and the covering of the sac until this has been freely exposed. Then the sac itself is split from the opening below upward to the region of the internal femoral ring, care being taken to avoid any pressure whatever upon the intestine. In this way the gut may be thoroughly examined, and a radical operation may be done subsequently if deemed advisable.

Radical Operation for Femoral Hernia.—The indications for radical operation in femoral hernia are the same as those considered in connection with inguinal hernia. As a rule the incision is made parallel to Poupart's ligament. The sac is exposed, lipomata and bursae are removed, and one should investigate to determine whether a portion of the bladder has been pulled down by the hernia or not. The neck of the sac should be isolated with extreme care and tied off, and the hernial canal should be closed as accurately as possible. The conditions for accomplishing this are much more favorable than in inguinal hernia because of the absence of any cord. On the other hand, there is considerable difficulty because of the firm nature of the canal, and simply closing the external femoral ring would accomplish little more than closure of the external abdominal ring in inguinal hernia. Modern methods attempt to close the entire canal, including the internal ring, although the methods formerly used have been found sufficient in certain cases. Berger reported the first cases of closure of the external ring in 1892. The sac is tied off, and the ends of the ligature are passed through the entire thickness of the abdominal wall with a blunt aneurism-needle and tied over the fascia of the external oblique. In this way no funnel-shaped depression remains in the region of the old hernia. The margins of the canal are approximated by stitches which pass through the periosteum of the pubes and through Poupart's ligament.

Bassini has called attention to the fact that Poupart's ligament and the fascia lata are relaxed in femoral hernia, so that the radical operation should endeavor to bring these structures again into their normal position. He exposes the sac by an incision close to and parallel to Poupart's ligament. After carefully isolating the sac it is opened and the hernia reduced. The sac is then twisted once in its long axis, clamped in the region of the neck, where it is transfixed, and tied off

both ways. The stump is dropped back into the abdominal cavity. The canal itself is closed by six or seven sutures from within outward. These include the periosteum of the pubes, the pectineal fascia, and Poupart's ligament. The last stitch lies close to the saphenous vein, and between this and the crural vein a space of about 1 cm. (0.3 inch) is left so as to avoid constricting this vessel. The stitches should be placed first before tying it, and the row of sutures forms a C-shaped line which in the middle is somewhat retracted and lies close to the pubes. Bassini examined 41 of the patients two to nine years after operation, and found no recurrence. Kocher applies his methods of operating in inguinal hernia also to femoral hernia, and makes an incision over the inner third of Poupart's ligament, exposes the sac as far as the internal ring, reduces the contents, incises the aponeurosis of the external oblique in the vicinity of Poupart's ligament, and brings the sac out through this opening, where it is held in place by a suture and the sac in the region of the hernial ring is fastened by several stitches which pass through Poupart's ligament, the pectineal fascia, and the thickened periosteum of the pubes. Three stitches of this sort pull Poupart's ligament downward in the region of the femoral vein, so that it acts as a prolongation of Gimbernat's ligament as it were. The superfluous portion of the sac is removed.

Fabricius makes an incision parallel to Poupart's ligament, isolates the sac, and ties off as high up as possible. Poupart's ligament is then separated from its insertion, the vessels are pulled outward, and the ligament sewed to the periosteum, muscles, and fascia, over the horizontal ramus of the pubes. The first stitch is placed close to the large vessels, and the remaining stitches are carried inward as far as the spine of the pubes, five or six being necessary as a rule. Finally the fascia lata is sewed to the pectineal fascia internal to the vein. This author recommends that the pillars of the external abdominal ring should be approximated by a few sutures because they are somewhat separated by the above technic. In a case operated by Gersuny the femoral hernia was cured, to be sure, but an inguinal hernia made its appearance later. A further objection is that there is danger of sewing Poupart's ligament down so firmly that the pressure upon the vein is followed by marked œdema.

Salzer closes the ring of large femoral ruptures by making a flap of the pectineal fascia with some superficial muscular fibre, with the base toward the pubes. This is then fastened to Poupart's ligament. Trendelenburg has endeavored to close the opening by a periosteal flap with bone chiselled from the symphysis and turned upward behind Poupart's ligament and held in place by catgut ligatures. In 3 of 5 cases the result was favorable, and the method can be recommended in very large femoral hernias with a widely distended hernial ring. It is evident that in cases of this sort there will be no suppuration. Heteroplastic experiments have been reported by Schwartz, Salzer, and Thiriar, who used catgut, glass wool, and decalcified bone. The latter method showed 21 cures, and in 2 cases the bone had to

be removed because of suppuration. The chances of a permanent cure are much better in small than in large hernias. Socin in 1879 reported 6 cases which were cured by tying off the sac and then sewing up the skin; and Heidenthaler, in 1890, reports that in femoral hernias no larger than a hen's egg cure was three times as common as recurrence, whereas when the hernia was larger than this there were twice as many recurrences as cures. Modern methods show that about 2 to 5 per cent. of the cases recur, just as in inguinal hernia. Bassini reports the proportion to be as 41 is to 0; Berger, 25 to 0; Championnière, 21 to 0; Eiselsberg, 11 to 1; Kocher, 11 to 0; Schulten, 7 to 0; Weigel, 36 to 1—*i. e.*, there were 2 recurrences in 152 cases, which is about 1.3 per cent.

Inguinal and Femoral Hernia on the Same Side.—Berger called attention to the fact that these conditions not infrequently are present on one side at the same time. He observed this state of affairs 222 times; 87 times on both sides; 203 men and 19 women. Usually there is a hernia elsewhere. In 105 of the cases there was an inguinal hernia on the other side. Sometimes the inguinal hernia appears as a separate tumor, although they not infrequently appear as one mass which is divided somewhat by Poupart's ligament. In these cases there is really extreme relaxation of the abdominal wall rather than a true hernia. The condition is rarely associated with strangulation.

Differential Diagnosis of Inguinal Hernia, Femoral Hernia, and other Conditions.—Diagnostic Scheme.—Macready collected the common sources of error in making a diagnosis of hernia. Certain of the data contained in his work will be mentioned here. He reports in all, 739 false diagnoses in men and 85 in women. The conditions confounded with scrotal hernia were as follows: hydrocele, 233 times; inflammation of the testicle, 107 times; varicocele, 90 times; non-inflammatory conditions of the testicle, 28 times; tuberculosis of the testicle, 17 times; and tumors of the testicle, 13 times. The following conditions have been confounded with femoral hernia: enlarged lymph-glands, 115 times; abscess, 47 times; enlarged saphenous vein, 9 times; and psoas abscess, 7 times. Labial hernia has been confounded with cysts 12 times, varicosities 6 times, psoas abscess 3 times, enlarged saphenous vein 26 times, and enlarged glands 22 times.

The vast majority of the congenital hernias and most of the ruptures occurring in the first ten years of life are inguinal. Wernher collected 5341 cases of femoral hernia, and found none under one year of age, 2 in boys and 5 in girls under five years of age, and 19 in boys and 13 in girls between six and ten years of age. He also collected 37,873 cases of inguinal hernia, and found that 4818 boys and 252 girls under one year were affected, 1568 boys and 253 girls between one and five years of age, and 991 boys and 195 girls between six and ten years of age.

Anything appearing distinctly above Poupart's ligament is inguinal, and in men the inguinal canal can be palpated in reducible hernias, while in women this is frequently impossible because there is no skin

available to be pushed in ahead of the finger. A femoral hernia rarely rises above Poupart's ligament, and in old women it sometimes descends into the femoral region; moreover, Poupart's ligament is apt to be so relaxed and covered with fat that it is difficult to find. The difficulty in making the diagnosis is not apt to be so great in men as in women. When it is impossible to determine the attachment of Poupart's ligament, the spine of the pubes may be used as a guide, for an inguinal hernia will appear above and to the median line, while a femoral hernia is more apt to appear outside and below. An inguinal hernia is very apt to cover up the spine of the pubes completely, whereas a femoral hernia leaves it uncovered. The peduncle of a femoral hernia lies immediately behind the tumor mass, whereas in an inguinal hernia it extends upward and outward. If it is possible to reduce the hernia, it is best to close the ring with a finger and request the patient to strain or cough while in the upright position. If the questionable condition is a femoral hernia, it will appear again immediately, and in this case, provided the hernia is reducible, one as a rule will be able to introduce the finger sufficiently to feel the pulsation of the femoral vessels and perhaps the margin of Gimbernat's ligament. It may happen, however, in femoral hernia that after replacing the same it does not come down no matter how great the effort. When the hernia is irreducible, the difficulties are still greater, and one should always bear in mind that two sorts of hernia or a hernia with other conditions may be present at the same time.

Congenital hernias, or those appearing in the inguinal region in the first decade, are always oblique, although when very large it may be difficult to differentiate. Sometimes it is possible to distinguish an oblique from a direct inguinal hernia by pressing upon the canal. If the hernia is direct, it will reappear immediately on coughing. As a rule it is difficult or impossible to feel the pulsation of the deep epigastric artery. If the cord lies entirely to the outer side of the sac, the hernia is without doubt direct. An oblique hernia almost always comes down into the scrotum if large, whereas a direct hernia may remain for a long time in the bend of the groin. Both varieties may be present at the same time, and even the most experienced diagnostician cannot determine the exact conditions.

All hernias present at birth, or appearing during the first weeks without any especial cause, are congenital. Furthermore, if a hernia extends into the scrotum immediately, it is liable to be congenital. A long cylindrical sac, early adhesions between the sac and the contents, irreducible hernia in other positions, constricted areas in the sac, simultaneous presence of circumscribed collections of fluid, the presence of a strand-like communication between the fundus of the sac and the tunica propria of the testicle, the presence of hernia with ectopia of the testicle, and the absence of symptoms with sudden appearance of a hernia, are points all in favor of a congenital origin. In favor of acquired hernia would be the late and gradual appearance, associated with characteristic symptoms and the history of accidental causes, such

as coughing or heavy lifting, the presence of hernia elsewhere, and a distinct interval between the testicle and the fundus of the sac. Furthermore, if there is a hydrocele of the cord behind the hernia, the condition is more liable to be acquired.

A systematic method of examination may be followed out as follows:

I. History: hereditary disposition (?), duration of the swelling (?). Since birth? How soon after? How did it appear? Sudden? Painless? Gradual? With pain? Cause of appearance? What was first noticed? Enlargement of the tumor from below upward or from above downward? Trauma? Bruises? Straining while at work? Fall? Coughing? Constipation? Pregnancy? Development of the tumor? Slow or rapid increase in size?

What were the early and the later symptoms, and what are the present? Disturbances of digestion? Difficult stool? Localized or diffuse pain? Spontaneous or on pressure? Pain dependent on position, movements, or taking of food?

II. Present condition:

1. Region of the swelling? Relation to Poupart's ligament, to the spine of the pubes, to the pubes? If in the scrotum, which side?

2. Size and shape of the tumor? Spherical? Cylindrical? Pear-shaped? Hour-glass? Smooth? Irregular? Uniform? Kinks?

3. Has the mass a peduncle, or is it free and movable? How far can it be lifted off and palpated? Size of the peduncle and direction?

4. Does the tumor change in size on standing up or lying down? In the morning or in the evening? Does coughing, straining, crying influence the size or tension?

5. Condition of the overlying structures? Is the skin normal? In folds? Tense? Scarred? Œdematous? Reddened? Thickened? Movable or adherent?

6. Is the tumor soft? Tense? Elastic? Fluctuating? Compressible? Of regular or irregular consistence? Light or heavy?

Can certain portions of the mass be distinguished—such as the testicle, the epididymis, the cord, the coverings of the testicle, the tunica vaginalis propria? If the normal structures in a tense scrotal tumor cannot be mapped out, this is in favor of distention of the tunica vaginalis propria. The position of the testicle and of the cord, of the round ligament, to the tumor?

Ectopia of the testicle? Position? Can the tumor be divided into two parts by pressure? Can certain organs be made out in the tumor—intestine, omentum, ovaries, bladder? Percussion? Auscultation? Intestinal noises? Translucency? Exploratory puncture?

Can the size of the tumor be changed by slight or marked prolonged or sudden pressure? Where does it disappear to? In which direction? Does it disappear at once or suddenly? With murmurs, such as gurgling noises, or without? What remains behind? Is the testicle and its covering reduced at the same time? Do the efforts at reduction cause pain? Is it possible to follow along with the finger

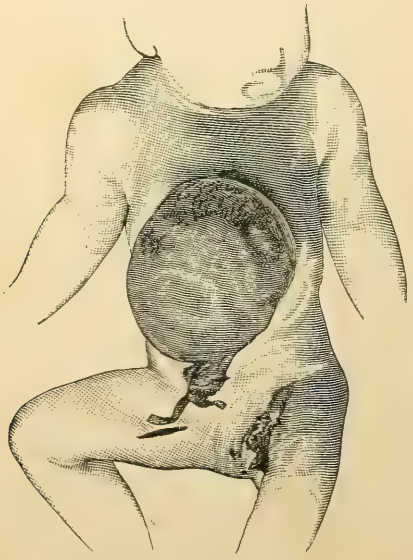
the course the tumor has taken? What is the condition of the coverings remaining outside? Are they smooth or movable?

Can one palpate the hernial ring? What is its anatomical position? Size? Margins? Neighboring structures? Does the finger enter the abdominal cavity, or is there some organ interposed? Was reduction associated with nausea, unconsciousness, or pain? When lying down, does the tumor remain in the abdominal cavity, or does it reappear immediately? Or does it come down on coughing, standing, or straining? Does it come down partially or entirely? Is it possible to determine the route taken by the mass on reappearing? Does alternating compression of the inguinal canal or external ring give any information on coughing? If the mass is irreducible, can any connection be made out with the abdominal cavity? Can the cause of the irreducible nature be made out, such as a strand or tension within the abdominal cavity? Are there signs of strangulation or of inflammation?

UMBILICAL HERNIA.

This subject will be subdivided into: 1, congenital hernia of the cord; 2, umbilical hernia of infants; and 5, umbilical hernia of adults.

FIG. 281.



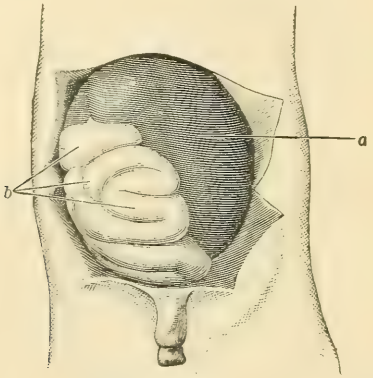
Hernia of cord.

1. Congenital hernia of the umbilical cord (ectopia viscerum) should really be classified as a malformation, and is frequently associated with disturbances of growth elsewhere. The slight cases resemble a hernia, and will therefore be considered in this connection.

During the first weeks of life the abdominal cavity communicates

freely with the umbilical vesicle by means of the vitelline duct. After the vessels of the placenta have become developed, the abdominal walls close toward the end of the third month and the peritoneum covers the surface uninterruptedly. A little fossa can be made out by pressing down with a finger or by pulling on the umbilical cord. At a certain stage of development the lower portion of the small intestine, and usually the cæcum, lies outside the peritoneal cavity in the umbilical cord. The communication between the umbilical vesicle and the small intestine is the vitelline duct. Normally the small intestine increases in length and forms loops that lie within the abdominal cavity. The effect of this traction is that the intestine lying outside

FIG. 282.



Hernia of cord—sac opened: *a*, liver; *b*, intestine.

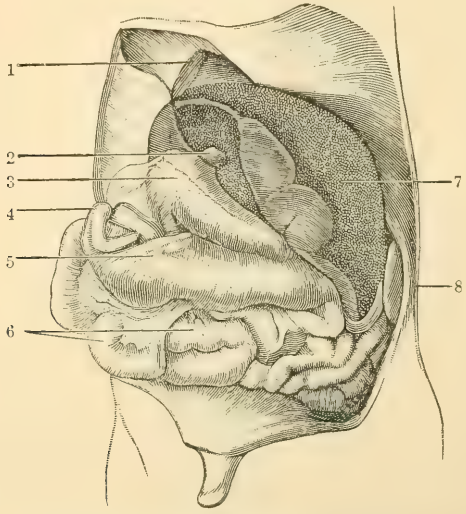
of the abdominal cavity is pulled in more and more until the communication finally tears off or remains as a thin strand, which can frequently be found at birth. This traction on the small intestine often produces a diverticulum which stands off from the ileum at right angles, and is not uncommonly attached to the umbilicus by a thin strand which may extend into the umbilical cord for a certain distance. This diverticulum is known as Meckel's diverticulum. After the intestine has retracted from the region of the umbilical cord the abdominal walls close in around the umbilical vesicle, and normally about the third month all that is left is a firm connective-tissue ring in the abdominal wall known as the umbilical ring. The prolongation of the peritoneum extending into the umbilical cord retracts more and more, and in the later months of intra-uterine life all that remains is a small dimple in the region of the umbilicus. The skin extends up on the cord for about 1 cm. (0.4 inch), and is separated from the amniotic covering of the cord by an irregular line.

If the cord is tied off after birth about 5 cm. (2 inches) outside of the umbilical ring, the remaining portion of the cord will die off, because it has no vascular supply. The umbilical arteries become obliterated because they have no branches. The cord itself dies off up

to the place where there is the usual vascular supply—that is, up to the skin margin. The granulating wound heals over, and the umbilicus is therefore covered by scar-tissue and does not contain any subcutaneous fat. This region does not have the same power of resistance as normal skin, and when distended becomes stretched more and more.

At birth the umbilical ring is of considerable size because it must allow free passage to the large vessels. As the vessels become obliterated this ring closes down more and more, especially in the deeper part, where the remnants of the umbilical arteries become transformed into fibrous connective tissue, which is closely adherent in this region.

FIG. 283.

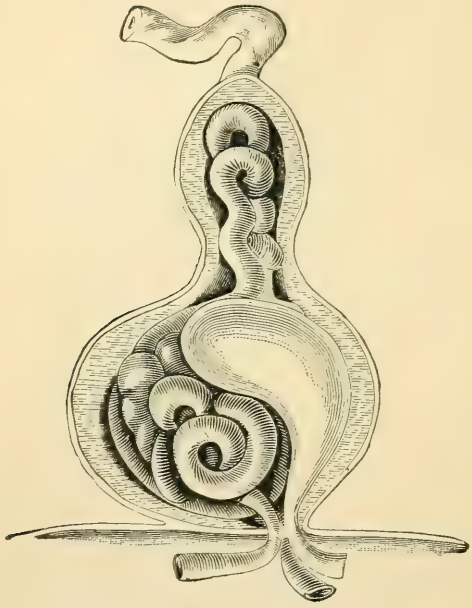


Hernia of cord—contents separated: 1, diaphragm; 2, gall-bladder; 3, stomach; 4, appendix; 5, colon; 6, small intestine; 7, liver; 8, spleen.

The umbilical vein in the upper part of the ring has no connective-tissue sheath, and does not become adherent to the umbilical opening, but accompanies the artery downward. This explains how it is that in the upper region of the ring, where the vein is not adherent, there remains a small gap which is insufficiently closed during the first few months of life. Below the umbilical ring there is the intra-abdominal fascia, and beneath this the peritoneum. This portion of the fascia is strengthened by connective-tissue fibres in the linea alba that sometimes show a distinct free margin 1 to 2 cm. (0.3 to 0.7 inch) above the umbilical ring (fascia umbilicalis, Rachet). Faulty development in this region is not uncommon, and a large part of the abdominal contents such as the small intestine, large intestine, liver, stomach, spleen, and kidneys, may be found outside of the abdominal cavity. Usually, however, only a small portion of the small intestine and perhaps some of the cæcum will be found outside. If there is a prolapse of the intestine, the abdominal walls cannot, of course, close, and may

even be only rudimentary, while the sharp line between skin and amnion persists. The prolapsed structures are covered by two layers which are transparent and contain a slight amount of connective tissue resembling Wharton's gelatin. The external layer consists of amnion, and the inner layer might be called peritoneum, except that it contains no vessels. Only where the prolapsed viscera are adherent do vessels sometimes develop, and it is fair to suppose that they are always secondary to inflammation. It is probably correct that the internal layer is really not part of the parietal peritoneum, but part of the so-called primitive membrane.

FIG. 284.



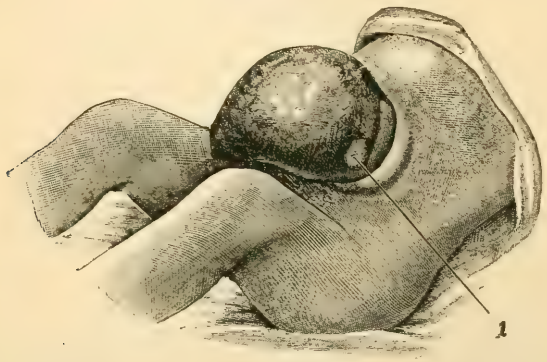
Congenital hernia of the cord containing liver and intestinal loops. (Kirmisson.)

There are, however, undoubted cases of congenital hernia of the umbilical cord that develop after complete closure of the abdominal cavity around the vessels. These hernias are never so large as the former, and contain almost always small intestine and omentum. There is usually a protrusion of the parietal peritoneum in the region of the umbilical cord which pushes the two arteries apart below and displaces the vein upward. It is difficult to explain how this condition could have been produced during intra-uterine life. It has been attributed to pressure upon the abdomen, but it is difficult to say how this could have been produced.

As far as the appearance is concerned, there are two varieties of hernia of the umbilical cord. One has a broad base and is of considerable size, being perhaps 25 cm. (9.5 inches) in circumference. The skin reaches only to the margin, and is then folded inward, so that a

peculiar roll is formed around the margin. (Fig. 302.) The main part is covered by a translucent membrane, which usually in the lower portion is connected with the umbilical cord. The umbilical vessels will usually be found united to a strand in the left side of a hernia and passing into the cord. The second variety appears as a pedunculated tumor, protruding through a comparatively small dilated umbilical ring, and extends into the cord as a cylindrical mass for a few centimetres. The margin between the skin and the amnion is quite distinct. These protrusions into the cord may be overlooked, and cases have been reported in which the included portion of intestine was tied off with the cord. This cannot happen if one is careful, for the abnormal contents are easily palpated because of the thin overlying layers. In this variety it is uncommon to have any adhesions

FIG. 285.



Congenital hernia of the cord: 1, seat of attachment of the umbilical cord to the tumor.

between the abdominal wall and the viscera. They are, however, quite common in the first variety. These conditions resemble a hernia because they increase in size with exertion and become tense. At birth the thin membranes are usually smooth, shiny, moist, and transparent, so that the contents can be more or less recognized. Several cases have been reported in which the sac ruptured at birth so that the intestines were exposed. These glistening membranes are not viable. They die off with the cord, and become first cloudy and then opaque. When the prolapse is considerable, the internal membrane and the intervening gelatin of Wharton will die off in certain places and become torn. Cases, however, have been reported in which the underlying layer was preserved and became covered with granulations, which in turn were covered in from the margin of the surrounding skin. Contraction of the scar-tissue may be associated with marked diminution in the size of the mass, although a favorable result of this sort is quite exceptional. The smaller the hernia into the cord, the more liable this favorable termination.

In the majority of the cases the children die within a few hours after birth, and should they live, fatal peritonitis is apt to develop as

the overlying membranes become gangrenous. If it is possible to prevent decomposition of the dying membranes, it will in all probability be possible to avoid this fatal peritonitis. When an operation is counterindicated, the following rules should be adhered to: In tying off the cord great care should be taken to avoid occluding any viscera. The region should be carefully cleansed and disinfected, and covered with some antiseptic powder and an aseptic bandage which should be changed whenever wetted. In this way one may be hopeful of saving the underlying layer after the superficial layer has been cast off. Not infrequently an intestinal fistula appears after the membranes have been cast off, which closes in some cases within a short time. Certain authors claim that this condition is due to strangulation of a piece of intestine contained within the umbilical cord, although the author considers that it is in all probability due to persistence of the omphaloenteric duct and connected with Meckel's diverticulum, because if this becomes strangulated there need be no other symptoms of intestinal obstruction. Formerly a hernia of the umbilical cord was left to itself, but of late operative treatment has been advocated. The first efforts in this direction were those of Berard, in 1840. Felsenreich reports a case in 1884, and MacDonald in 1890 collected 19 operations with 17 cures and 2 deaths. Only 3 of 12 cases unoperated recovered. Lindfors collected 44 observations from 1882 to 1893; and of the 32 cases operated upon, 26 recovered and 6 died. Of 5 cases in which a subcutaneous ligature was used, 3 were cured and 2 died; and of 7 cases that were treated by expectant methods, 3 were cured and 4 died. Several of those that recovered were very unfavorable, because there were adhesions to the organ, or the hernia contained the liver and stomach, and in some there was already evidence of peritonitis.

In uncomplicated cases in which there is a likelihood that conservative treatment will be successful, one should wait before interfering radically until the children's power of resistance is increased. In the cases, however, in which conservative treatment is not effective, or in which there is some urgent indication, such as an already existing rupture of the sac, or when the contents are irreducible, when there are signs of strangulation and beginning peritonitis, an immediate operation is indicated. The cases in which the hernia is so large that there is no chance whatever of covering in the defect are, of course, excluded from operation.

A free incision should be made so as to be able to deal with any unexpected complication that may arise, and because it is much easier to reduce the contents, especially if there are adhesions. The incision should be made in the skin close to the amnion. The hernial tumor should be freely exposed and the regions where the contents are adherent to the lining of the sac freed by excising part of the membrane. For the purpose of reducing the hernia it may sometimes be necessary to enlarge the incision upward and to close the wound later, layer by layer. When an operation is urgently indicated, it may

be done immediately after birth; but, if possible, one should wait until the second or third day.

Subcutaneous methods are not to be recommended, because of the danger of accidental injury. In some of these cases it may be well to follow Olshausen's advice and operate extraperitoneally—*i. e.*, without opening the inner lining. The amnion and Wharton's gelatin are separated from the underlying tissue, and the sac is then folded over and sewed in place, while the freshened edges of the skin are brought together above this. The dangers of this operation are less, to be sure, but one is never certain of the result, at least not to the same degree as with other operations.

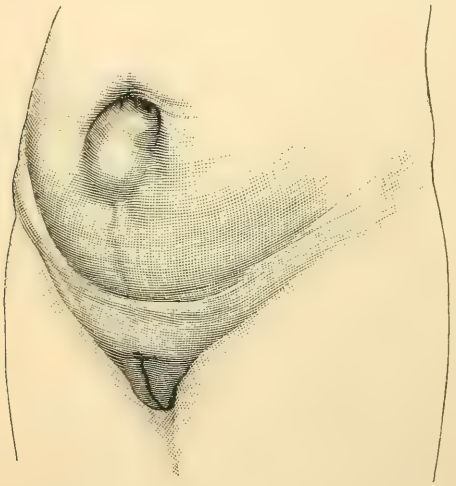
2. Umbilical Hernia of Young Children.—The umbilical ring, which does not close tight for the first few weeks of life, is a weak spot in the abdominal wall. In certain cases the umbilical fascia is of sufficient strength to hold back the abdominal contents, but as it is not always uniformly developed, it does not always do this, although it may prevent direct protrusion from within outward. It may cover in a little of the umbilical ring, and if the peritoneum is to bulge in this region it must extend downward over the margin of this fascia. The seat of exit therefore would be in the upper portion of the umbilical ring, between its free margin and the umbilical vein. Every child is predisposed to umbilical hernia in the early months of life, and if there is much crying, or chronic constipation, or difficulty in urinating because of phimosis, and especially if the child coughs much, it is not surprising that this weak spot in the abdominal wall gives way. Pulling upon the umbilical cord is also disastrous, because it produces a depression on the inner side of the abdominal wall. Umbilical hernia is very common in the first year of life, although it is difficult to obtain accurate figures, because the majority of the cases never come under treatment, and without doubt a large proportion of these hernias disappear early without medical aid. Frequently, however, there remains a slight depression or a slight bulging of the peritoneum, and the umbilical ring is somewhat larger than usual. The hernial opening is usually narrow and the upper margin is apt to be very sharp. The sac itself is very delicate, and is usually adherent over the cicatricial region of the umbilicus. A hernia of this sort is conical, and rarely larger than an inch in diameter. The sac almost always contains small intestine, because during the first year of life the omentum does not extend this far. The contained intestine may be so movable that it goes back of its own accord when the child is on its back, but appears immediately on straining. The place where the umbilical star is, can always be recognized in the lower lateral portion of the tumor, and remains adherent to the umbilical ring even when the hernia increases in size. Sometimes an especially distended scar lies upon the hernia proper as a separate diverticulum. Children with umbilical hernia suffer from frequent attacks of colic that cease after the hernia has been removed. Strangulation is uncommon, although cases have been reported.

Treatment.—Prophylactic measures are of the greatest importance. The cord should never be pulled upon, and the granulating umbilical wound should receive careful attention. An antiseptic of some sort, such as boric acid or iodoform, should be used, and any disturbance of the bowels, or of micturition, or coughing and crying, should receive prompt attention. If a small swelling develops in the umbilical region, this should be attended to promptly. The umbilical ring tends to close of its own accord, and the intestine does not find room in the small sac. The simplest and safest way of aiding nature is to apply adhesive plaster bandage after reducing the hernia. This should be done with the child on its back, and a small piece of wet cardboard should be strapped down directly over the opening. The strips of adhesive plaster should not be carried all the way around the abdomen, because if there is any distention they are liable to cause trouble. They should reach from the mid-axillary line on one side transversely across the abdomen, with two oblique strips above and below. A swathe is applied over this, which should be changed if soiled or when washing the baby. The success of this method of treatment depends largely on the character of the adhesive plaster. It should be such that it can be left in place while the child is being bathed, and may remain in place from four to six weeks. When these children are brought for treatment early, the hernia may be cured in about sixteen to eighteen weeks, although in certain cases in which the abdominal wall is not firm, and in which the rectus muscles are separated above, it may be necessary to continue treatment for years. If the hernia does not disappear eventually, there is usually some special reason, and in a case operated upon by the author after bandages had been tried for years, a fine strand of omentum was found adherent to the sac-wall. Special bandages and trusses are not to be recommended, because they constrict and excoriate and allow the intestine to appear again at short intervals when the apparatus is being changed. This, of course, destroys any advantage that may have been gained while they were worn. Those with small round pads are especially to be condemned because they tend to dilate the hernial ring; and if a pad is to be used, it should always be flat and extend beyond the margins of the umbilical opening. If the above-mentioned method of treatment is unsuccessful, then a radical operation should be performed, especially if the hernia is causing symptoms or continues to increase in size. A hernia that has not disappeared up to the tenth year of life should always be operated upon while the individual is still growing, because it is very apt to increase considerably in size later, especially in girls. The operation itself is simple, and with tractable children this may be done with Schleich's local anæsthesia. An incision is made in the long diameter of the tumor. This is carried down through the skin with great care because the covering is apt to be very thin and there is danger of injuring the intestine. The sac should always be opened because it is extremely easy to overlook some strand-like adhesion. The peritoneum should be closed with a continuous catgut suture or with a simple pucker

suture if possible. The umbilical scar is best excised, although the parents should be consulted in this respect, because of local superstition. The fibrous margins of the umbilical ring and the skin margins are next approximated. Silk is best for this purpose. The apposition of the edges of the wound should be very exact, because even the slightest gap may furnish the necessary guide for reappearance of the hernia.

3. Umbilical Hernia in Adults.—After the first year of life umbilical hernia is comparatively uncommon, and in males it is extremely uncommon. In females between the fifth and twenty-fifth year of life it is also uncommon, but after thirty years the condition is noticed much more frequently again, although the character of the hernia is quite different from that in young children. Those in children tend to remain small, while in adults they increase progressively and may become enormous. In all probability a certain proportion of the cases in

FIG. 286.



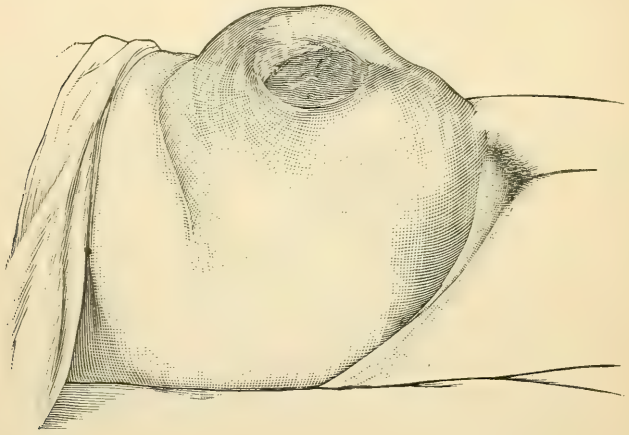
Umbilical hernia of adult.

adults develop in connection with a hernia that has persisted from childhood. The majority, however, are due to changes in the abdominal cavity during pregnancy or in connection with large intra-abdominal tumors, ascites, etc., when the umbilical scar becomes much distended and is not capable of contracting because of the absence of elastic fibres. After the primary distention has ceased the hernial ring and sac remain. Berger collected 6220 cases of hernia in males, and found only 134 cases of umbilical hernia, whereas in females there were 496 cases in 2229 hernias. In males a large umbilical hernia—at least in adults—is found only when there is some special predisposition to hernia—*i. e.*, when there are hernias in other regions. Of the 134 cases above mentioned in males over fifteen years of age, there were only 15 that had an umbilical hernia alone. In 95 of the cases there

was a bilateral inguinal hernia, and in 12 a unilateral inguinal hernia. In the 494 cases of umbilical hernia occurring in females, however, only 56 were combined with a hernia in other regions, and in 438 the local defect was all that could be found. The prevalence of this condition in women is chiefly due to pregnancy, and of the 496 women with umbilical hernias, 429 had been pregnant and 377 were multipara. Each succeeding pregnancy was associated with an increase in the local condition.

The hernia has a distinct tendency to increase, and even the hernial ring may become 7.5 cm. (3 inches) in diameter, whereas the tumor itself may be as large as a man's head. Not infrequently the hernia has a mushroom appearance. There is a short, thick peduncle with an overlying mass spreading over the surface. The coverings are made up of peritoneum, connective-tissue fibres in the region of the ring,

FIG. 287.



Umbilical hernia of adult.

and sometimes a few strands of the obliterated umbilical vessels. There is no subcutaneous fat and the sac is apt to be extremely thin. Certain of the cases, however, have thickened sac-walls, and occasionally a fatty tumor develops in this region. The skin in the region of the umbilical scar is always extremely thin and adherent to the umbilical sac, so much so that the layers cannot be separated even with a knife, although this is quite easy in the lateral portion of the sac near the base.

As a rule the sac contains omentum and small intestine, or omentum and transverse colon. Sometimes the cæcum is contained, or even the stomach. In 2 cases reported by Léotam and Murray the uterus was found in an umbilical hernia. The intestine is not apt to be adherent, whereas the omentum is very liable to be attached to the wall in several places. Sometimes this apron is ruptured and transformed

into firm strands that may be the cause of strangulation. It does, however, happen that the intestine itself may be adherent over a large area. The adhesions are frequently very close, and the exact relations are sometimes impossible to make out because of the many pockets with the strands and firm adhesions in the sac.

It is not uncommon to have a portion of the hernia extend outward between the skin and the muscles, and it is quite characteristic of umbilical hernia to find the sac extremely irregular. The cavity may be subdivided by partitions and bridges of tissue into numerous smaller cavities, some of which may become entirely closed off and form cysts. These separate cavities not infrequently communicate with the chief cavity by small openings with sharp margins, and offer conditions most favorable for strangulation. Riedel reports a case in which a very small loop of intestine had become strangulated in a secondary small sac in the wall of an umbilical hernia the size of a child's head. Cases have been described in which a properitoneal diverticulum was connected with the sac of an umbilical hernia (hernia umbilicoproperitonealis). This properitoneal sac may extend upward (Sänger) or downward (Terrier) for a considerable distance; the exact condition, however, is detected only on operation.

Small umbilical hernias, especially in fat women, do not produce any tumor that can be appreciated on inspection. On palpation, however, the intestine may be felt to slip back from beneath the fingers with a characteristic snapping or gurgling noise. In the course of time large umbilical hernias become irreducible as a rule, because of inflammation and secondary adhesions. The constant friction of the clothing not infrequently results in superficial ulcerations which may extend inward, and, combined with the tendency of the hernia to increase and have thinner and thinner walls, result in rupture of the wall and peritonitis.

Treatment.—A small umbilical hernia in an individual that is not very fat can easily be held back by a truss, while in obese individuals this may be impossible, especially if the hernia is large. In most of the cases the abdomen is pendulous, so that the problem is very complicated, and the trusses show considerable tendency to become displaced in spite of perineal straps and shoulder-straps. If the especial appliances constructed by Virol, Langaard, Löwy, and others, prove inefficient, it may be best to rely upon some elastic abdominal support, with or without a pad in the region of the hernia. The pad should be made over a plaster-of-Paris cast of the hernia, so as to fit accurately. Beely's abdominal support is very efficient, and consists of two leather plates, a triangular one in front and a square one behind, that are held together by lateral straps and perineal bands. Hoffa describes in the *Centralblatt für Chirurgie*, 1896, No. 20, an abdominal support which is still more efficient. In spite of the supports, the patients frequently continue to have colic, vomiting, and suffer from constipation, etc. Besides these daily symptoms, it happens occasionally that fecal matter becomes impacted in the prolapsed por-

tion of gut, and inflammations in this region are not uncommon, particularly if the hernia is large and irreducible. If the greater part of a hernia was reducible at some previous date, it is no longer so when these conditions exist. Rest in bed with frequent poultices and abstinence from food help attacks of this nature to pass off without grave results. Patients with large umbilical hernias sooner or later become accustomed to a certain amount of discomfort, and are only apt to consult a physician when the condition becomes threatening. They are unwilling to accept his advice, and wish to have the methods tried that helped them in previous attacks. This explains how it so often occurs that operations for umbilical hernia are postponed much too long. Besides, physicians themselves are apt to wait a considerable time because they are undecided whether the condition is really due to harmless circumstances, or whether there is strangulation. The first few days are passed in using half-way measures, while the condition of the patient remains fairly good. Remissions are not uncommon, although the disturbance is not severe. The tumor is not tense nor especially tender to touch, even in the vicinity of the umbilical ring. There need be no vomiting and the bowels do not always cease to act entirely. Suddenly the symptoms become aggravated. The vomiting becomes continuous, the pulse gets worse, and symptoms of peritonitis soon appear. If an operation is undertaken at this time —*i. e.*, on the fifth or sixth day—an intestine is found which is ready to rupture, and the outlook is, of course, unfavorable. For this reason strangulation of umbilical hernia is especially feared, although in itself no different from any other hernia. Severe acute cases of strangulation occur with small umbilical hernias, just as in cases of femoral hernia, for instance. When an umbilical hernia, however, is large and irreducible, the symptoms develop gradually, but in time the results become equally as bad.

A loop of intestine may become strangulated in one of the diverticula of the main sac and be overlooked, because the main bulk of the hernia is soft and not tender to touch. In these cases one should always palpate the mass carefully to see whether there is not some area more firm than the rest and more sensitive to pressure. If the symptoms are marked in cases of strangulation, radical measures should be resorted to immediately, and taxis should be used only in exceptional cases, because the vast majority of large umbilical hernias are irreducible. The sac should always be opened during the operation because the complicated conditions can only be unravelled in this way. The sac itself is extremely thin, so that great care must be taken when opening. Adherent omentum should be tied off in sections and removed. It is sometimes necessary to divide strong adhesions between the intestinal wall and the sac, and it may even be necessary to excise a portion of the sac. If the conditions allow, one should always perform a radical operation after opening the sac. Generally speaking, a radical operation is indicated much more frequently in umbilical hernia than in inguinal or femoral hernia, because they are

difficult to retain with trusses and show a much greater tendency to increase in size, besides being associated with severe complications.

Should a radical operation be done while the hernia is rather small and not especially adherent, then this step is very simple and almost without danger, and the chances of a permanent cure are very favorable.

There are two methods of operating which have an equal number of supporters. One method consists in making an incision over the hernia in its long axis, exposing the sac and its contents, closing the sac, and uniting the soft parts over this. The other method consists in making a circular incision around the hernia and removing the skin that has become stretched, as well as the sac and its coverings. The defect is then closed by a plastic operation. The first method does not expose the field of operation thoroughly in complicated cases, and does not permit the abdominal cavity to be freely inspected with regard to adhesions. One should never be satisfied unless thoroughly convinced that the replaced intestine lies absolutely free within the abdominal cavity. The second operation, called omphalectomy by Condamin-Bruns, is much to be preferred because of the free exposure of the field of operation, and because one is able to complete the operation much more quickly. It has, however, the disadvantage that in a large hernia there may be considerable trouble in closing the defect. For this reason some authors claim that it is best not to carry the incision entirely around the hernia, but be satisfied with doing one side first, and at the end of the operation remove as much of the flap as can be spared. After exposing the hernia itself it is best to attend to the omentum first and tie this structure off in sections. After this has been done the intestine may be attended to. Bruns claims that it is best to close the wound by through-and-through sutures, taking in all the structures of the abdominal wall at one time. Although it would seem that this method does not guard against recurrence as well as some others, it has the advantage, especially if silver wire is used, that it can be done in a short time, and that a great deal of tension may be put upon the stitches. Most authors prefer to sew up layer by layer. The peritoneum is closed with a continuous catgut suture, then the deep fascia, then the muscles, then the superficial fascia, and finally the skin. Biondi tries to prevent the lines of suture from lying immediately one above the other by dividing the peritoneum and the posterior sheath of the rectus transversely. The rectus muscle itself is separated longitudinally, the anterior sheath of the rectus transversely again, while the skin is divided vertically. This method is especially valuable, as emphasized by Eiselsberg and Bumm, when it is easier to bring the structures together transversely. After an operation for a large umbilical hernia it is always best to have the patient wear some sort of abdominal support.

A large umbilical hernia that has existed for a long time is not infrequently associated with conditions that render the prognosis doubtful. The patients are frequently obese, advanced in years, have fatty hearts,

and are chronically constipated, so that the results of the primary operation are not especially good. The mortality is about 10 per cent. Recurrences are common, and are proportional to the size of the hernia. Berger collected 54 cases and found the results to be as follows:

2	Cases of enormous hernia	2 recurrences.
25	" " large "	8 "
13	" " the size of a fist	2 "
14	" " small hernia	1 recurrence

It is of very great importance whether the wound heals by first intention or not, for of 10 cases in which suppuration occurred there were 6 recurrences.

OBTURATOR HERNIA.

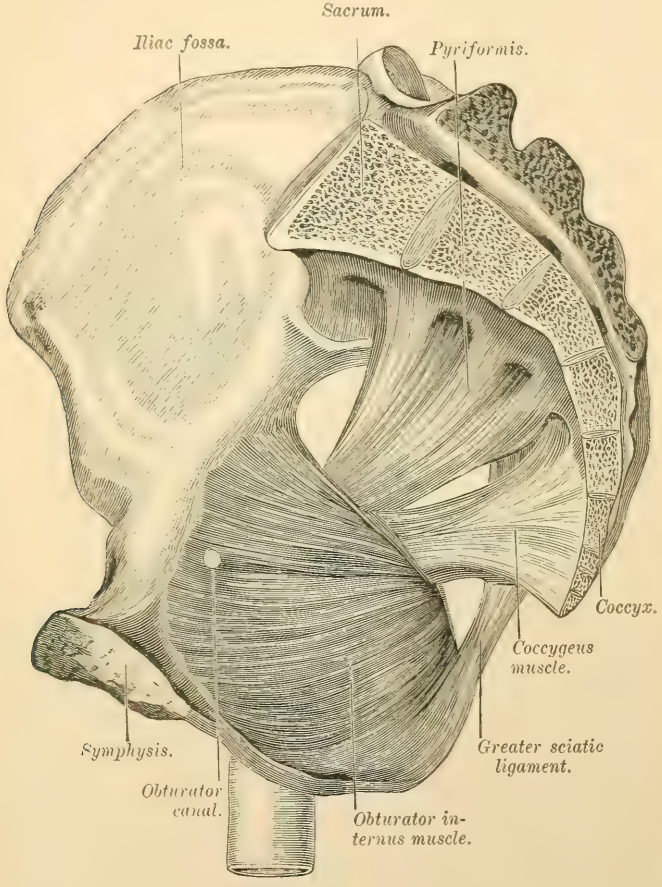
About 200 cases have been reported in literature, and the subject has been gone into with especial care by Fascher, Englisch, Picque, and Poirier. The hernia always leaves the abdominal cavity through the same foramen. The obturator foramen is closed except for the upper portion by the obturator membrane, which consists in this region of two layers, between which there is sometimes a slight amount of fat. The upper and inner portion of the membrane presents an opening which corresponds to a groove on the pubes for the passage of the obturator nerve and vessels. These vessels pass through the obturator internus and externus in a space known as the obturator canal, the direction of which is inward, downward, and forward, its length being about 1.5 cm. (0.6 inch), while its diameter is about 1 cm. (0.4 inch). Behind the obturator internus and its fascia there are the intra-abdominal fascia and peritoneum. Thin people sometimes have a slight depression over the internal opening of the canal. The nerve usually lies above and outside; the vein inside and below, and the artery between. The branches of the obturator nerve given off in the canal subdivide the obturator externa, which in the region of the external opening is covered by the pectineus with the connective tissue of the subinguinal triangle overlying this.

Obturator hernias are found chiefly in old women (Berger, 118 women, 18 men). They are not infrequently bilateral, or combined with ruptures in other regions, especially in the femoral region. The sac usually contains small intestine or a portion of the gut-wall, sometimes omentum, vermiform appendix, bladder, and quite frequently some portion of the female genital apparatus, such as an ovary or tube, or even the uterus. (Brunner.) In a typical case the sac follows the vessels along through the canal and appears above the upper margin of the obturator externus immediately beneath the ascending ramus of the pubes. It is covered by the pectineus muscle, and because of the thickness of the overlying structures the condition may exist for a considerable length of time before producing any noticeable swelling.

When present, this swelling will be found in the triangle bounded internally by the adductor longus, externally by the femoral artery, and above the ramus of the pubes—*i. e.*, in the region where one would expect to find a femoral hernia.

Diagnosis.—The diagnosis is quite difficult, although most of the cases are recognized before operation, but generally after symptoms of strangulation have appeared. A small tumor will be found immedi-

FIG. 288.



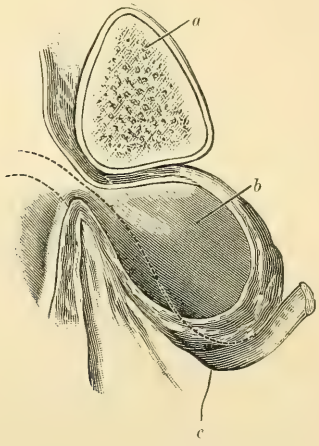
Inner wall of pelvis.

ately below the pubes, to the inner side of the large vessels, and should be compared with the conditions on the healthy side. The examination should be made with the thigh in different positions, but it will be found most advantageous to relax the muscles by flexing, adducting, and rotating the thigh outward. This position relaxes the pectineus, as well as the adductor and iliopsoas. The ascending ramus of

the pubes should be followed backward and outward with the finger, and sometimes it will be possible by bimanual examination to detect a strand reaching up to the anterior wall of the pelvis. If no tumor can be made out, localized tenderness to pressure, which is almost always present if there is any strangulation, is a valuable sign. One should always investigate whether there is any increase in the amount of pain when the obturator externus is put under tension—*i. e.*, when the thigh is abducted and rotated inward.

Romberg's symptom is extremely valuable when present, and consists in disturbances in the regions supplied by the obturator nerve. As a rule the thigh will be held flexed, cannot be adducted, and any

FIG. 289.



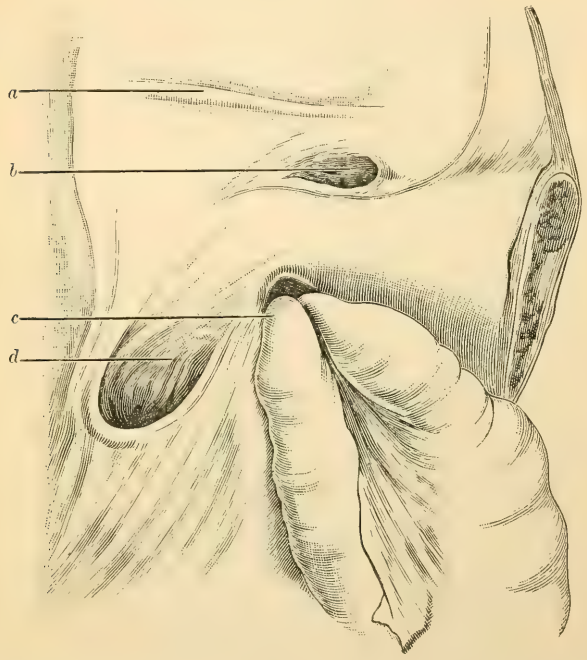
Section of left obturator hernia seen from within: *a*, pelvis; *b*, sac; *c*, thigh.

motion whatever causes pain. The symptoms may be continuous or may recur as attacks at intervals of varying length, and are due to pressure upon the nerve-trunk in the obturator canal. Most of the pain is referred to the inner side of the thigh, although the hips and knee-joints may also be involved. It should be remembered that one branch of the nerve, because of its communication with the long saphenous, reaches almost down to the middle third of the leg. The symptoms are by no means uniform, and it should be remembered that these nerves may be irritated by other conditions than a hernia. Rheumatism, neuralgia, perimetritis, and purulent peritonitis in the iliac fossa should be borne in mind in this connection. Landerer reports a case in which the symptoms were due to osteomyelitis of the pubes, and in which there were also signs of intestinal obstruction. The symptoms of strangulation are usually thought to be due to internal strangulation, so that one should always examine the hernial regions very carefully when signs of this sort are present. It should

also be remembered that a femoral hernial and an obturator hernia may be present on the same side and at the same time. It has also happened that an inguinal hernia or an umbilical or crural hernia has been treated while the obturator hernia was found on autopsy. (Auerbach, Paci, Wilke, Martini.)

Treatment.—On account of the deep position in the thigh and the mobility in the region, the technical difficulties of operating are very great, and up to the present time only one case has been reported which was operated upon before symptoms of strangulation appeared. The results are still unfavorable. Taxis is absolutely to be condemned.

FIG. 290.

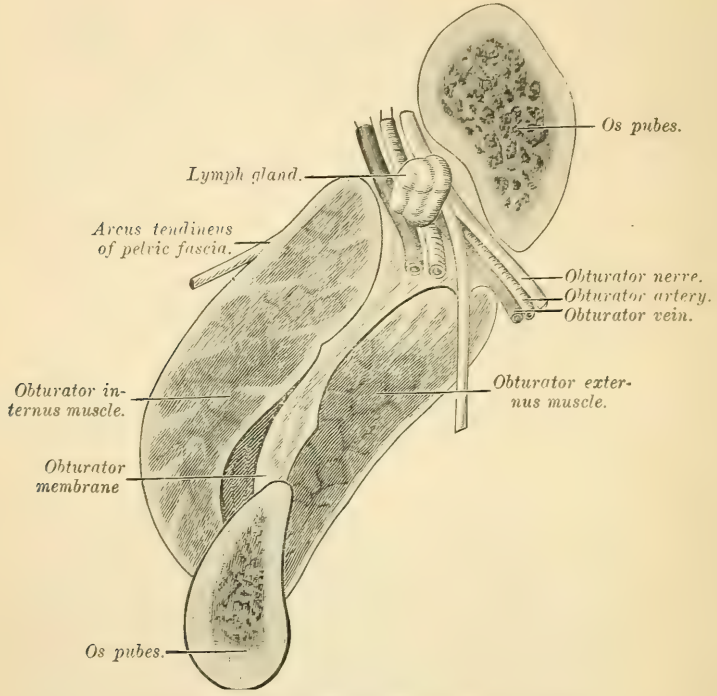


Obturator hernia seen from within true pelvis: *a*, Poupart's ligament: *b*, internal inguinal ring; *c*, neck of hernia; *d*, obturator membrane.

The firm constricting bands produce gangrene of the gut within a very short time, especially if the wall of the intestine has been caught. Care should be taken during the operation not to allow the gut to slip back into the peritoneal cavity, and large incisions should be used so as to expose freely the field of operation. The pelvis should be raised and a long incision made along the inner margin of the saphenous vein. After dividing the fascia the inner edge of the pectineus muscle is exposed, and if necessary, the attachment to the pubes is divided, so as to be able to get to the seat of trouble. The hernia is freed from the surrounding tissue, the sac is opened, and if the gut looks suspicious, it should be handled with the greatest care. Riedel

resected a piece of the pubes, and considers that this should be done in all difficult cases. The operation is liable to be bloody, because

FIG. 291.



Section through obturator region and obturator canal.

it is difficult to avoid the surrounding vessels. It will be found best to enlarge the opening downward and inward.

VENTRAL HERNIA.

The varieties of hernia that have just been described occurred in regions that could be anatomically defined, whereas the following cases may have little in common as far as their anatomical relations are concerned. In certain regions of the abdominal wall it is not uncommon to find a rupture, such as in the linea alba, which may be subdivided into hernia paraumbilicalis and hernia epigastrica, and besides these there are the cases occurring in the lineæ semicircularis. A great many of these cases are due to protrusion of a lipoma developing in the subperitoneal fat and adherent to the peritoneum through some gap in the abdominal wall. They are found not infrequently along the course of the vessels, for instance, in the mammary line, where these structures perforate the muscle diagonally. In other cases there may have been some preliminary disease associated with suppuration of the

abdominal walls, or there may have been bruises, subcutaneous lacerations of muscles with the formation of blood-clots, or perhaps some

Fig. 292.

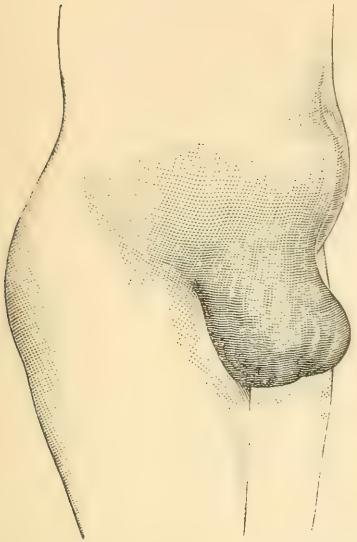
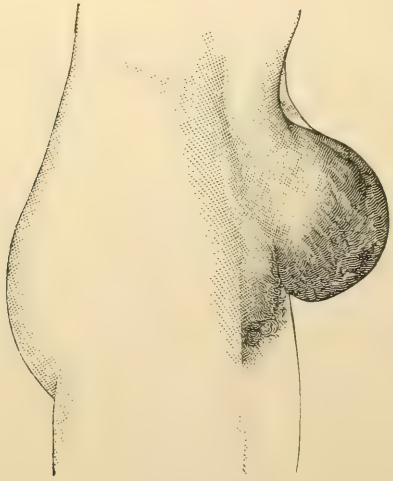


Fig. 293.

Hernia in appendix scar.

Fig. 294.



Post-operative hernia.

previous laparotomy provided for the favorable conditions. The anatomical relations differ, of course, according to the primary cause. When the hernia follows some trauma or an operation, the sac may be incomplete for a considerable distance, and the viscera are covered

only by a thin layer of scar-tissue. Strictly speaking, a case of this sort should not be classified as hernia, but should be spoken of as a prolapse. Those due to some previous operation are included in the term "hernia of a scar."

Hernia in the Linea Alba.—It is not uncommon to find the recti muscles considerably separated even at birth. This separation may extend from the symphysis to the ensiform process, but as a rule the condition is more common above the umbilicus, or when present throughout the separation is greater above. The condition is probably a congenital defect, although in later life a similar state of affairs is frequently observed, especially in women who have been pregnant repeatedly at short intervals, or when there has been some great distention of the abdominal cavity. The bulging is more noticeable on standing up, when the abdominal walls are relaxed. If the patients are told to lie down, it is sometimes possible to push the abdominal wall inward and examine the entire cavity. The gap is best appreciated if the patients are told to raise the head while in a horizontal position, which puts the muscles under tension. The congenital condition frequently gets well of its own accord; at least the condition is seen much less frequently in children that are older. Sometimes there are separate openings in the fascia with sharply defined dense margins through which a true hernia may come, and even without any separation of the recti muscles it is not uncommon to find small slits in the upper portion of the linea alba through which a hernia appears. They have been called epigastric hernias. A special name has been given them on account of their practical importance. The hernia is usually small, and in obese individuals may not produce any bulging of the surface, although occasionally it is sufficiently large to produce a hemispherical prominence of the abdominal wall, or may hang downward like a pouch with a long pedicle.

Subperitoneal lipomata probably always are of some etiological importance, and not infrequently the entire tumor mass is made up of a lipoma, behind which the peritoneum is drawn outward in a funnel-shaped manner. The fat extends outward between the fibres of the linea alba, which become more and more separated, and finally become firm and dense and form a distinct hernial ring. As a rule there is only one opening, although several superimposed rings have been observed, as in Berger's case, in which four small hernias were found one over another, each of which could be reduced separately. When cutting down upon little tumors, one not infrequently finds that the condition seems to be a simple lipoma, for nothing betrays the funnel of peritoneum behind until the tumor itself has been removed. The sac may be empty, although it is not uncommon to find a piece of omentum, and sometimes a loop of intestine, especially the transverse colon. It is not proved that they may contain the stomach.

In Berger's statistics, including 10,000 cases of hernia, there are 137 cases of epigastric hernia, 120 of which were in males, and the majority were associated with hernias elsewhere, especially in individ-

uals well advanced in years who were considerably emaciated. Witzel claims that the condition was more common in people with some gastric disturbance, perhaps because of the emaciation and vomiting. Other authors consider that they may be of traumatic origin, and Witzel claims that 50 per cent. of the cases may arise in this way. A direct blow upon the stomach or lifting may be the primary cause, or an already existing hernia may be sufficiently enlarged by these factors to become noticeable.

These hernias frequently produce considerable disturbance, although not always. The patients have frequent attacks of colic of a boring or pulling character, and they vomit. The abdomen may be distended and there is difficulty in moving the bowels. Besides this there is frequently a distinct sense of depression, palpitation, and the individuals may even become unconscious. The pain is intermittent and appears after some sudden motion, especially after overextension of the trunk. In other cases the pain appears regularly at a stated interval after eating. The continual discomfort and fear of impending pain make these people unable to follow any occupation ; they become disgruntled, hypochondriacs, and emaciate progressively.

Symptoms.—Because of the symptoms referable to the stomach, it has frequently been supposed that this organ was the subject of more or less violent insult. However, the majority of the cases contain omentum and transverse colon ; but it is possible that the stomach is pulled upon because of the ligamentum gastrocolicum. It is also possible that the symptoms are due to bruising and traction upon nerve-trunks in the region of the hernia, especially in the cases in which the lipoma is not firmly connected with the peritoneum. As a rule the lipoma contains a small diverticulum of peritoneum which becomes filled sooner or later with omentum or intestine. The attacks of acute discomfort are probably due to slight strangulation, such as are noticed in the early stages of hernia elsewhere, especially in the femoral region. On examination it is very easy to overlook the condition entirely, although an experienced observer will discover a small soft swelling in the linea alba which is somewhat sensitive to pressure and slips from beneath the finger, leaving a small depression in the abdominal wall. The symptoms of which these patients complain, such as repeated attacks of pain, gastric disturbances, etc., are not uncommonly referred to some other condition, such as an ulcer of the stomach or biliary colic, the clinical picture of which may be very similar.

Treatment.—Trusses are usually useless, and a small epigastric hernia in itself is perfectly harmless. If, however, there is marked discomfort, then the only relief is in a radical operation. The technic is not difficult, although the operation must be done with great care, and the sac should always be opened so as not to overlook any adhesions. An incision should be made a little larger than the diameter of the tumor, the hernia should be exposed, and the pedicle freed down to the hernial ring. The sac is then opened, the adhesions tied

off, and the sac with the lipoma excised. The margins of the ring should be freshened and sewed together just as in umbilical hernia.

Hernia of the Linea Semicircularis.—This variety of hernia is found where the fascia of the transversus abdominalis becomes continuous with the posterior sheath of the rectus, therefore at the outer margin of this muscle. Cooper was first to call attention to the fact that numerous small vessels pass through the abdominal wall in this region, and that the muscles may be somewhat separated around these vessels, so that the gap in the wall is already formed. In other cases, however, the separation is secondary, and is produced by the sac extending outward along the vessels. In certain of the cases the peritoneum after penetrating the transversus spreads out between the layers of the abdominal wall and reaches the surface at some distance from the opening, through which it primarily escaped. In these cases the sac may be quite complicated and consist of a subcutaneous and a subperitoneal portion. The condition is most common in older people, especially women who have borne several children, although individual cases have been reported in children by Monroe and Macready. Schoofs reports a case in which the testicle was found in a sac of this sort.

Diagnosis.—The diagnosis may be very difficult, because the hernia is small and is covered by a thick layer of fat. The condition may be recognized because of localized pain, which becomes worse when the abdominal muscles are put under tension; for instance, during attacks of coughing, and frequently disappears entirely on lying down. In other cases the symptoms may be much more marked, resembling those of epigastric hernia. Palpation not infrequently detects a point of localized pain. A large hernia is easily recognized, but one should be careful to investigate whether or not there is a second sac into which the contents of the external sac may be pressed. It is not uncommon to have these cases strangulated. The condition is frequently severe because of the sharp fibrous margins that produce considerable constriction. All of these cases should be operated upon, especially if the exact condition cannot be detected. A hernia appearing to the outer side of the linea semicircularis is known as a lateral abdominal hernia, and is observed after some injury or suppurative process, or as the result of some congenital muscular defect or acquired muscular paralysis. (De Quervain.) As a rule they are described in connection with lumbar hernia.

Hernia in Abdominal Scars.—These are the result of some injury or suppurative process, and may occur anywhere in the abdominal wall. They may follow a stab-wound or some crush of the abdominal wall without any external wound where the muscles become destroyed either by the injury itself or because of the hæmatoma that develops. The cases that appear after some operation are much more common, and are found usually in the median line or in the appendix region. They are extremely common when the primary operation was done for some suppurative process which made it necessary to keep the abdominal

wound open for a considerable length of time. They also develop in cases in which the wound does not heal by first intention or in which for some reason or other it has been necessary to keep the wound open for the purpose of treatment.

The condition sometimes develops after wounds have healed by first intention, and at the present time the common opinion is that a simple through-and-through suture is not sufficient for closing the abdominal wall, but that the peritoneum, fascia, muscles, and skin should be sewed separately. Abel examined 586 patients some time after operation and found that 20 per cent. of the cases closed by simple through-and-through sutures presented a hernia, and that only 9 per cent. of the cases sewed layer by layer showed a similar condition. If there had been suppuration for two weeks, 40 per cent. presented a hernia; for three weeks, 54 per cent.; for four weeks, 65 per cent.; and 80 per cent. of the cases that suppurated for more than four weeks had a hernia; while 68 per cent. of the cases closed by through-and-through sutures that suppurated showed a hernia, and only 31 per cent. of the cases that were sewed layer by layer.

There are two kinds of hernia in the scar; one where the cicatricial tissue is uniformly distended and presents a condition resembling separation of the recti muscles; in the other variety the condition is more like a true hernia, because the peritoneum bulges through a hole in the fascia, which has rather sharply defined margins. In the latter variety, however, the condition is simply due to the giving way of weaker portions of the scar. Certain of these hernias into the scar become extremely large. The overlying tissues are greatly thinned, and the skin is apt to become ulcerated because of ill-fitting bandages, etc. These ulcers may eventually open up the hernia or even perforate the intestine. The omentum and intestine are commonly adherent to the sac and diverticula are not uncommon. The symptoms are generally in proportion to the size of the hernia, and cases of strangulation are uncommon.

Treatment.—The same difficulties are met with in fitting any appliance as in umbilical hernias, and a proper abdominal band is to be preferred to any truss with a spring. When the recti muscles are separated in young children, adhesive plaster bandages, as already described, may be tried. The same applies to hernia in the linea alba. Those operated upon may be instructed to use adhesive plaster bandages, and change them from time to time, as the only means of preventing a hernia into the scar, according to Fritsch.

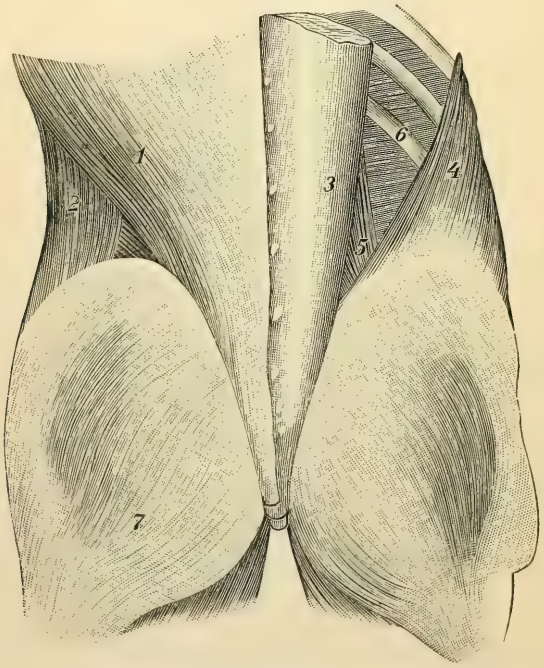
If these conservative methods do not result in improvement, then a radical operation should be advised. The technic is much the same as that of operations for umbilical hernia, and especial care should be taken to free the sac from the hernial ring completely and remove any adhesions that may be present. The abdominal wound should be closed layer by layer, and when the hernia is large it may be well to use a few silver wire sutures which include a considerable portion of the abdominal wall, and which are removed in about fourteen days.

Bumm has recently succeeded in closing certain difficult cases by placing the sutures transversely and then keeping the patients doubled up for a considerable length of time, so as to diminish as much as possible the tension on the line of suture. It is, however, not at all uncommon to have a recurrence after operations for hernia in abdominal scars.

LUMBAR HERNIA.

The abdominal cavity is closed behind first by the spinal column and laterally by the sacrospinal muscles. To the outer side of these the wall is not quite so firm, and is formed by the quadratus lumborum, the external and internal oblique, and the transversalis. The abdominal muscles arise in part from the crest of the ilium, in part from the lumbodorsal fascia. The individual layers of muscle do not

FIG. 295.

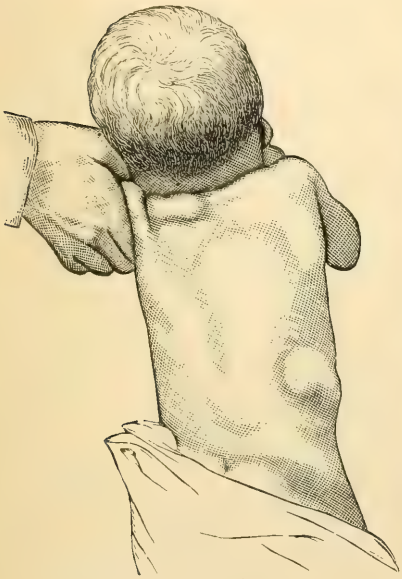


Dorsal muscles in the region of the lumbar triangles: 1, latissimus dorsi; 2, external oblique; 3, sacrospinal; 4, internal oblique; 5, quadratus lumborum; 6, twelfth rib; 7, gluteus maximus.

all reach back to the sacrospinal group, so that there are certain weak places left in the wall. The external oblique is 3.5 cm. (1.4 inches) from the erector muscle at the twelfth rib and 4.5 cm. (1.8 inches) below. The internal oblique is 5.5 cm. (2.2 inches) away from this margin above and 1.5 cm. (0.6 inch) below, while the transversus is 6.5 cm. (2.6 inches) away throughout its entire length, so that there is

quite a space left which is in part closed in by the quadratus lumborum, which arises from the posterior portion of the crest of the ilium, the fifth lumbar vertebra and the iliolumbar ligament, and is inserted into the transverse processes of the four upper lumbar vertebræ and the lower margin of the twelfth rib. In the lower portion it extends outward beyond the free margin of the sacrolumbar group, and in this region the abdominal wall is closed in partly by the lumbodorsal fascia, as shown in the accompanying diagram. There are two lumbar triangles, the larger of which has its base along the twelfth rib, while the smaller has the crest of the ilium as a base. The upper one is bounded internally by the sacrolumbar muscles, externally by

FIG. 296.



Congenital lateral ventral hernia. (Wyss.)

FIG. 297.

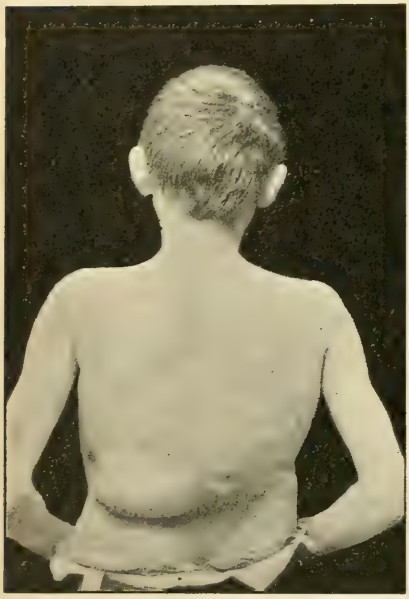
Lumbar hernia.

the posterior margin of the internal oblique, and the apex is in the region of the crest of the ilium. The lower triangle is situated between the free margin of the latissimus dorsi and the external oblique. The apex of this small triangle is formed by the margins of these muscles, and the space itself is known as the triangle of Petit. The upper larger triangle is covered in almost completely by the latissimus dorsi. This muscle, however, cannot be included as one of the layers of the abdominal wall proper.

Lumbar hernia is rarely congenital, and is usually acquired in advanced years when there is general debility, or it follows pregnancy or some other marked distention of the abdominal wall and when there is continued violent coughing. The number of cases that have

been examined anatomically is very small, so that up to the present time there is much difference of opinion as to which region belongs the term "lumbar hernial ring." Certain cases of hernia leave the upper triangle, which is known as the costolumbo-abdominal, while others appear in the region of Petit's triangle. Besides this there are cases that do not follow either of these routes, but appear at the side of the last intercostal artery or along the branches of the second and third lumbar nerves, and extend forward between the muscle layers. In the majority of cases, however, there is a distinct defect of the muscular structure. Wyss describes a case of this sort as hernia ventralis lateralis congenita. This appeared through a gap in the internal and external oblique and transversalis, which was associated with absence

FIG. 298.



Lumbar abscess from spinal caries (rear view).

FIG. 299.

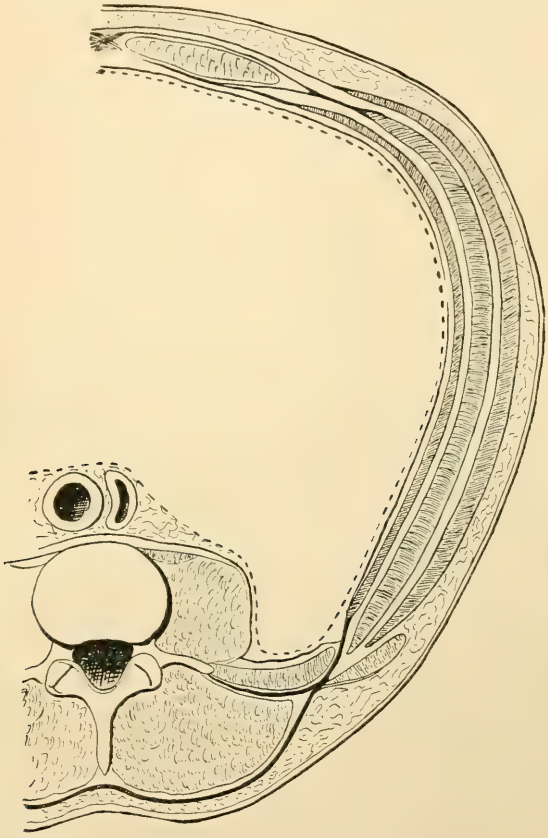
Lumbar abscess from spinal caries (side view).

of the twelfth rib. Macready reports similar cases. Grange has recently collected 45 cases, in 20 of which the anatomical conditions were accurately described; 9 of the hernias occurred in the region of Petit's triangle, 2 in the costolumbo-abdominal triangle, and 3 were associated with some congenital muscular deformity, and in 1 each there was a congenital defect of the ileum, 1 case was due to necrosis, and 1 occurred in a scar, and in 3 cases the hernia followed along vessels and nerves through the muscles; 20 of the cases were on the left side, and 16 on the right side; 2 were bilateral; 18 were in males and 5 were congenital. As a rule these hernias are covered by a layer of muscles, which, however, becomes gradually pushed back, so that

the sac lies eventually immediately beneath the skin. According to certain authors, there are cases without any sac, the hernia consisting of fat, or some abdominal viscus without any peritoneal covering, such as the ascending or descending colon.

Diagnosis.—The diagnosis is not difficult in a well-defined case, although disastrous mistakes have been made. The condition is not

FIG. 300.



Transverse section at the level of the second lumbar vertebra (lumbodorsal fascia).

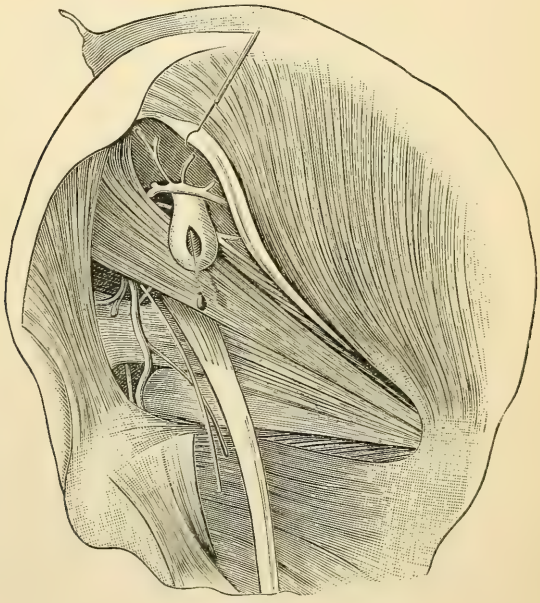
infrequently confounded with a cold abscess, and has been opened for such, whereby the intestine has been injured. The condition has also been confounded with a lipoma or a hernia of the muscles.

Treatment.—A movable hernia may be held back by some appliance. Whenever there is any strangulation, the case should be operated upon immediately and a radical operation done after the field has been liberally exposed.

GLUTEAL AND SCIATIC HERNIA.

The greater and the lesser sciatic notch are separated one from the other by the small sciatic ligament, and are bounded below by the great sciatic ligament. The great sciatic foramen is filled up largely by the pyriformis. Besides this, the superior gluteal vessels and nerves leave above the muscle, the inferior gluteal, the sciatic artery and nerves, passing out below the muscle. The obturator internus leaves the pelvis through the lesser sciatic notch, and the internal pudic artery and nerve pass over this back into the pelvis. There are therefore three regions where the peritoneum may bulge: along the upper margin of the pyriformis, then along the lower margin, and

FIG. 301.



Gluteal hernia. (Garrè.)

finally through the lesser sciatic foramen. All three varieties of hernia are extremely uncommon. Many of the cases formerly considered to be such were found by Garrè to be perineal hernias, for those appearing below the greater sacrosciatic ligament cannot be included as sciatic hernia.

The most common variety is that in which the hernia leaves the abdominal cavity between the upper margin of the pyriformis and the border of the greater sciatic notch. As a rule the hernia follows along the course of some nerve-trunk, while the gluteal vessels do not have any stated relation, but spread upward. After leaving the notch the hernia lies beneath the gluteal fascia and the gluteus maximus. It is quite a distance to the lower margin of this muscle, and after once

reaching this region the hernia increases quite rapidly in size and forms a distinct tumor, covering in the anal region and extending more and more toward the median line. It is difficult for the surgeon to decide without an anatomical examination which variety of hernia he has to deal with. The posterior perineal hernias also appear beneath the free margin of the gluteus maximus. Garrè suggests that the two superior varieties be called superior and inferior gluteal hernia, and the inferior variety leaving the lesser sciatic foramen sciatic hernia, a suggestion that ought to be followed.

Diagnosis.—The diagnosis is extremely difficult in small hernias lying beneath the muscles, but can be made if there are signs of strangulation, localized pain, and sensitiveness to pressure, as in the case reported by Wassilieff. The condition may readily be confounded with abscesses, cystic tumors, or lipoma.

Treatment.—When the symptoms are urgent, an operation should be performed immediately and the field freely opened up so as not to operate in the dark, because of the large vessels in the vicinity.

HERNIA OF THE FLOOR OF THE PELVIS (PERINEAL HERNIA; HEDROCELE).

This variety of hernia is very uncommon, and almost all of the cases are due to a bulging downward of Douglas' pocket. In embryos and very young children Douglas' pouch extends very much farther downward than in adults, and Ebner's investigations seem to show that the majority of these hernias are the result of some error of development. The peritoneal hernial sac is covered by a layer of pelvic fascia, and after descending rests upon the muscles of the floor of the pelvis, especially on the levator ani. This muscle is in relation behind with the ischiococcygeus and the coccygeus itself, between which there are not infrequently small spaces left. Sometimes the levator shows small slits. The peritoneal diverticulum descends through these openings into the ischiorectal fossa in the vicinity of the anus and drives the perineal fascia and skin forward. The transverse perinei muscles separate two varieties; the anterior and posterior perineal hernias. The latter are much more common. Winckel distinguishes three varieties in women, an anterior perineal hernia between the constrictor cunni and ischiocavernosus, which sometimes reaches the labia majora, and is therefore known as the hernia labialis posterior; the second variety appears between the constrictor cunni and the transversus perinei; and the third between the transversus perinei and the gluteus maximus. In man the hernia leaves through the rectovesical pouch, while in women this space is subdivided by the uterus and broad ligament into an anterior and a posterior pocket. If the hernia leaves through the anterior pocket, it almost always comes down into the labia majora and forms a posterior labial hernia. It may, however, reach the surface directly without being in any way connected with the labium. This variety of hernia might easily be confounded

with an inguinal labial hernia if the examination is not carefully made. One can distinguish the two, however, if the inguinal canal is carefully watched while the hernia is being reduced, especially if a vaginal examination is made at the same time, which will show that the hernia goes backward toward the uterus. In the anterior perineal hernias it is not uncommon to find the bladder with or without intestine. Synonyms are pudendal hernia or vaginolabial hernia. Up to the present time only 2 cases have been accurately described from an anatomical standpoint.

If the hernia comes down in the recto-uterine fossa, it will follow the same course as in males, and may descend between the vagina and rectum, but is very apt to produce bulging of the posterior wall of the vagina or of the anterior wall of the rectum. These cases have been called hernia vaginalis, or hernia rectalis, or hernia in recto.

According to Berger, there are two distinct varieties of posterior perineal hernia. In one there is no distinct separation between the sac and the large recto-uterine pouch, and the hernia appears as a uniform bulging. In the other variety the hernia is pedunculated, and is sharply separated from the general peritoneal cavity by a distinct sac neck. This latter variety may be confounded with a vaginal polyp when it is circumscribed and produces a bulging of the mucous membrane. The small ring is not infrequently the source of strangulation.

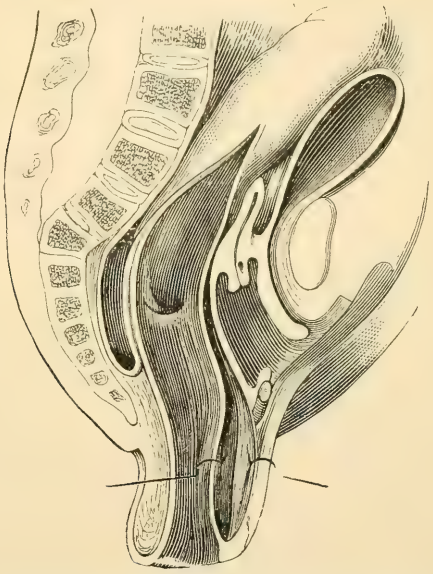
Diagnosis.—An error in diagnosis is only possible because of some careless examination or because of ignorance. The sac almost always contains intestine, is tympanitic on percussion, may readily be diminished in size, and goes back with distinct gurgling. The tumor becomes smaller and relaxes when the patient is lying down, is larger on standing up, on coughing or straining, and can usually be reduced. An error in diagnosticating may be very disastrous. Michaelson and Lukin report a case in which a tumor 8 cm. (3 inches) long appeared in the labium majus. The peduncle extended upward for some distance, and a diagnosis of polyp was made and the mass amputated. Later there were violent colic and vomiting, and the patient died the next morning. On autopsy an oval opening 5 cm. (2 inches) in diameter was found in the vaginal wall, and at the side of this the os uteri. It was discovered that 23 cm. (9 inches) of omentum and 11 cm. (4 inches) of colon had been excised. Gunz reports a case in which a vaginal hernia had been confounded with an abscess, and had also been incised with a similar result.

The discomfort associated with these hernias may be very great. Various appliances have been constructed, but as a rule the relief is not great. When the hernia is large, the patient may wear some sort of a suspensory. Only those cases are favorable for operation in which there is a distinct neck to the hernial sac, because only in these is there any hope of obtaining a lasting result. When there is extreme dilatation of Douglas' pouch, the inferior wall of the abdominal cavity is usually so relaxed that the chances of radical cure are very slight.

One would have to perform a laparotomy, in all probability, and try to diminish the size of Douglas' pouch by sewing the uterus to the pelvic wall. Gaillard-Thomas inverted the sac just as the finger of a glove, then performed a laparotomy and sewed the invaginated sac to the abdominal wall. Since operations have been performed for removal of tumors of the rectum and uterus, traumatic hernia in this region has been repeatedly observed. Hochenegg reports 3 cases of sacral hernia in women, and in 1 case he performed a radical operation.

There remain to be considered the cases of rectal hernia (rectocele, hedrocele, hernia in recto) that are found in connection with prolapse

Fig. 302.



Sagittal section through the pelvis of a girl eight years of age with prolapse of the rectum. The hooks separate the layers of the anterior sac of peritoneum. (Cruveilhier.)

of the rectum. (Fig. 302.) Ludloff has observed several cases recently, and comes to the conclusion that the hernia is the primary disturbance, and that the prolapsed rectum is secondary and the result of traction. A prolapsed rectum is really a perineal hernia, the sac of which is partly formed by the anterior wall of the gut.

The rectovesical fossa, or recto-uterine fossa, offers but little resistance to any force directed from above downward and backward. Under normal conditions the amount of resistance offered by the rectum itself as a hollow muscular tube is sufficient to resist any bulging up to a certain point. If, however, the intestinal muscles are abnormal because of chronic constipation or diarrhœa, then the relaxed portion of the intestine will be pushed downward and backward into the ampulla of the gut. If this force is applied repeatedly, considerable traction will be made upon the attachments of the intestine, and once

started, more and more small intestine will come down into the pouch formed in the wall of the rectum. The depressed portion of the abdominal wall gradually involves the lateral and posterior wall. In the angle where Douglas' pouch comes in contact with the gut there is a transverse fold within the lumen, known as the plica transversalis recti. The superimposed intestine outside of the rectum presses down on this structure, which becomes more and more depressed until this fold forms the apex of a prolapse of the rectum outside of the anus. The anterior lip of the prolapse always contains a pouch of peritoneum (hedrocele), which may or may not contain some abdominal viscera.

The above remarks explain how it is that the length of this variety of rectal prolapse is fairly constant; in children rarely more than 5 cm. (2 inches), and in adults not more than 10 to 15 cm. (4 to 7 inches). The longer variety belongs to the group of prolapsus coli invaginati.

A prolapse of the rectum with hedrocele almost always develops slowly, and the fact that the size of the tumor changes on lying down or on straining and coughing, indicates the presence of a hernia. Of the 96 cases collected by Ludloff, only 11 contained observations indicating the presence of a hedrocele, and in 13 cases observed by the author the condition was present 8 times, while in the remaining cases it could not be excluded. It is very common to have these hernias become strangulated, although they are sometimes irreducible.

Treatment.—As far as treatment is concerned, Mikulicz's method of resecting the entire prolapse and uniting the stump of the anus with the inner layer of the cylindrical tumor covered by serosa, is generally made use of. The cases run a favorable course and the results are good, as a rule. There is considerable danger of recurrence, because the peritoneal pouch still persists and reaches down close to the anus. Besides resection, it has been endeavored to meet the condition by laparotomy and suture of the intestine to the abdominal wall higher up. Massage has also been tried. (Brandt.)

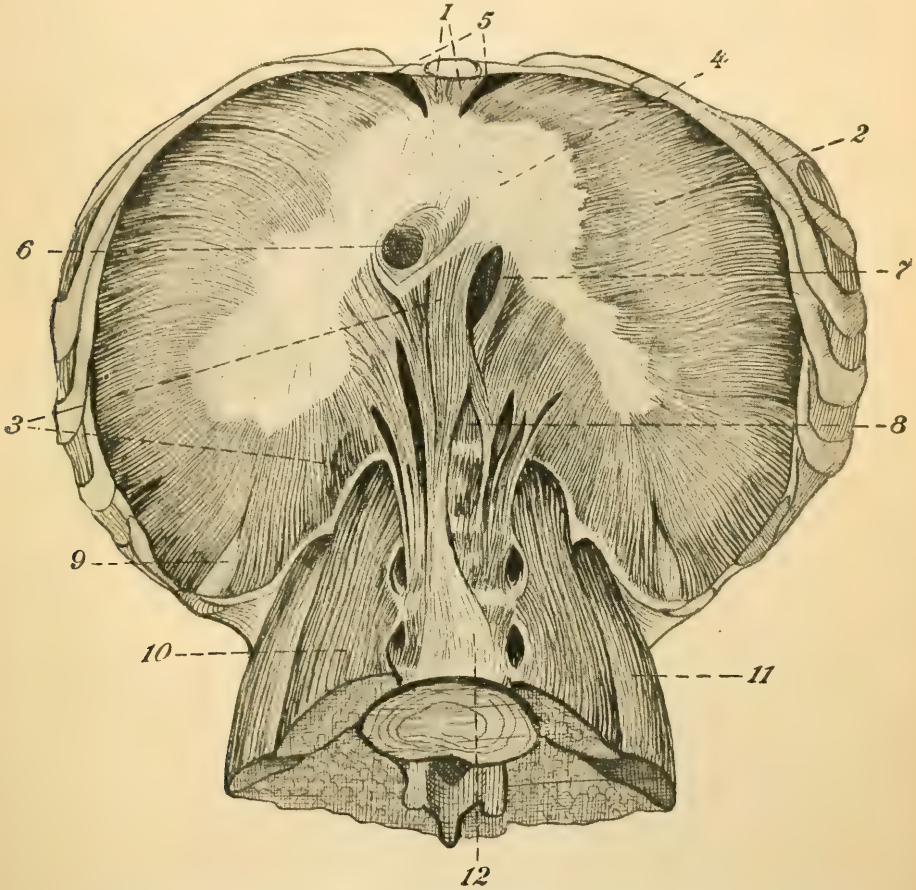
DIAPHRAGMATIC HERNIA.

If it be demanded that a peritoneal sac is essential to a hernia, then only a few of the cases described as diaphragmatic hernia can be considered as a hernia proper. The term hernia is used in a broader sense in this region, and includes all of the cases in which there is any displacement of abdominal viscera into the thoracic cavity. Displacements with peritoneal sac are known as true hernia, those without a sac as false diaphragmatic hernia, while both may be acquired or congenital. Certain of the cases should be considered defects of development, and many cases belong properly to the displacements following injury. Finally there is a group of cases in which there is an abnormal relaxed condition of the diaphragm, so that the vault is not

ruptured, but bulges upward, a condition described by Thoma as eventratio diaphragmatica.

According to Waldeyer, the diaphragm develops from an anterior and a posterior portion that unite in a median line, while a lateral communication exists on either side between the small thoracic cavity and the very large peritoneal cavity. The portion along the ribs

FIG. 303.



1, sternal portion; 2, costal portion; 3, lumbar portion; 4, central tendon; 5, foramen Morgagni; 6, foramen for the inferior vena cava; 7, foramen for œsophagus; 8, opening for aorta; 9, foramen Bochdaleki; 10, psoas magnus; 11, quadratus lumborum; 12, fourth lumbar vertebra.

behind and the external lumbar part unite last. If there is any disturbance of development, it is perfectly possible to have some displacement of the abdominal viscera, on the left side the stomach and on the right side the liver, which latter develops early to considerable size, and is rarely passed around. Even when the defect is very great the anterior portion of the diaphragm is usually present. The fact that the costal and lumbar portions unite late is important, because of the

gap frequently found in this region. Even when the serous membranes unite there is a gap left in the muscle, known as the foramen Bochdaleki.

The diaphragm is attached to the sternum, to the ribs, and in the lumbar region, and the aponeurosis forms the dome-like central tendon, which presents an opening for the vena cava inferior, known as the foramen quadrilaterum. In the muscular portion farthest back between the crura is the opening for the aorta and thoracic duct. In front of this is the opening for the œsophagus and pneumogastric nerves. The azygos veins and splanchnic nerves pass through smaller lateral symmetrical openings. Where the different muscular portions meet, there are not infrequently small gaps closed only by peritoneum and pleura. The one in front, which is constant, is situated between the sternal and costal portions, and is known as the foramen Morgagni, while the one between the lumbar portion and costal portion is known as the foramen Bochdaleki. The hernias that develop as the result of some defect of growth have, of course, no sac. The true hernias having a double sac, consisting of pleura and peritoneum, occur most frequently in the parasternal region—*i. e.*, they reach the anterior mediastinum through the foramen Morgagni. A hernia sometimes passes through some normal opening, most frequently through that for the œsophagus, next in frequency through the opening for the splanchnic nerves, and rarely through the aortic opening. No hernia has ever been reported through the foramen quadrilaterum. The hernia may be of considerable size, but is the subject of treatment only when signs of strangulation appear.

Traumatic diaphragmatic hernia is much more frequent and of more importance to the surgeon. In this group are included all of the cases produced by some injury to the diaphragm. The injury may be a blow, a stab- or gunshot-wound, or may be due to some indirect force which increases the intra-abdominal pressure to such an extent that the diaphragm becomes ruptured. Those cases in which the diaphragm is weakened is due to some disease, and ruptures following some slight increase of pressure also belong to this group (subphrenic abscess, empyema, carcinoma, etc.).

Not infrequently there is prolapse of the abdominal viscera into the thoracic cavity immediately following an injury, and strangulation occurs at once. There are, however, numerous cases in which the injury is not followed by immediate results of this sort. The wound may heal and leave a button-hole-like opening, lined with peritoneum and pleura, through which the viscera pass later because of some accidental cause. According to Lacher, of 36 cases of injury of the diaphragm that were not operated upon immediately, 5 died within one day, 10 within a month, 5 within five years, and 5 in twenty years, all of the effects of a diaphragmatic hernia. The statistics of other authors also show that symptoms of strangulation did not occur for some time after the injury, even after months or years. Almost all of these hernias are not true hernias, although in some of the cases there was a sort of sac, which, however, consisted of prolapsed omen-

tum or was the result of inflammation around the displaced organs. The acquired diaphragmatic hernias are chiefly on the left side, and generally in the fleshy portion. The liver protects the right side, although the fact that stab-wounds and gunshot-wounds are more common on the left side of the body is also of etiological importance. The traumatic variety may be subdivided into compound and subcutaneous hernia. The former will be recognized because of the characteristic position of the injury, and not infrequently by a piece of prolapsed omentum, etc. There may be no symptoms whatever in either case, and in spite of the extensive injury life may not be immediately endangered. Strangulation may develop, however, at any time, and then presents the usual symptom-complex of internal incarceration.

Diagnosis.—The chief point in the diagnosis is to remember that there is the possibility of a diaphragmatic hernia in certain cases. If abdominal viscera have entered the thoracic cavity, there will be the physical signs of displacement, referable especially to hollow viscera, and also symptoms due to pressure upon the thoracic organs. With prolapse on the left side, which is eight times as common as that on the right, the left half of the chest will be distended, and does not make any respiratory excursions. The area of cardiac dulness will be displaced to the right. Dextrocardia is so valuable a sign that when present one should always suspect a diaphragmatic hernia, provided there is not a left-sided empyema, a pneumothorax, or transposition of viscera, or some other cause. If a large quantity of the intestinal tract enters the pleural cavity, the physical signs may resemble those of pneumothorax. The differential diagnosis will be based upon the fact that the size of the air-containing cavity varies, that intestinal noises can be heard within the thorax, either spontaneously or produced artificially by carbon dioxide, that the diaphragm is high, and that the abdomen is flattened, contrary to the condition found in pneumothorax. Besides this, distinct swashing, due to fluid, can be appreciated, and recently the *x*-ray has shown that the intestines filled with gas or fluid could be recognized above the diaphragm, and that a rubber tube introduced into the stomach and filled with mercury could be seen in the thoracic cavity. The subjective symptoms of non-strangulated diaphragmatic hernia are much more complicated. The patients complain of symptoms referable to the circulatory and respiratory organs, or due to the displaced viscera and traction upon their connections to the trunk. There may be dyspnœa, due to compression of the lung or due to pressure upon the heart. This symptom is aggravated because of the reflex limitation of diaphragmatic breathing due to the injury. The symptom referable to the digestive tract is usually diffuse pain in the abdomen or under the ribs. There may be persistent dyspepsia, acid eructation of gas, vomiting which may be almost continuous, colic, and a sense of distention in the stomach. There may also be dysphagia, due to kinking of the œsophagus, and symptoms more or less typical of gastric ulcer. The abdominal symptoms are frequently aggravated by physical exertion.

The clinical picture is still further complicated when other organs have been injured besides the diaphragm. When large vessels have suffered, there will be signs of internal hemorrhage, and if the stomach or intestine has been opened, there will be evidence of peritonitis, whereas if the pleura has been infected, symptoms of pleuritis will complicate the picture. The latter symptoms may, of course, be the result of some infection of traumatic origin. Emphysema of the skin, hemorrhage from the stomach, and abscesses of the liver have also been reported at times. When symptoms of incarceration appear, either immediately or years after the injury, the clinical picture differs in no way from that of any other type of internal strangulation. It is therefore a fundamental rule with symptoms of strangulation to think of a diaphragmatic hernia in connection with obturator hernia, sciatic hernia, or perineal hernia.

Treatment.—Even though certain cases have recovered spontaneously after the development of fecal abscesses, it is evident that operative treatment and a radical operation are indicated whenever there are signs of strangulation. There is no palliative treatment for the non-strangulated cases. One might possibly recommend a limited diet and guard against physical exertion so as to avoid the danger of strangulation as much as possible.

Experience shows that most injuries of the diaphragm are followed sooner or later by fatal strangulated hernia, so that it has become a matter of routine, whenever an injury of the diaphragm can be recognized, to close the opening immediately. Fray, in 1893, collected 33 cases of injury of the diaphragm, 4 of which recovered, and 2 of these after operation. Berchthold, in 1897, collected 24 cases of injury of the diaphragm that had been operated upon, and found that 22 recovered and only 2 died. The chief source of danger in injuries of the diaphragm is from the damage done to other abdominal organs. When there is no doubt that this has happened, one should always perform a laparotomy first and open the chest later. After opening the abdominal cavity the viscera should be systematically examined and the opening in the diaphragm made accessible and inspected. It is best to make a transverse incision and have an assistant retract the viscera downward, while the costal arch is pulled upward. Besides this the patients should be placed in an almost vertical position, as recommended by Kelling.

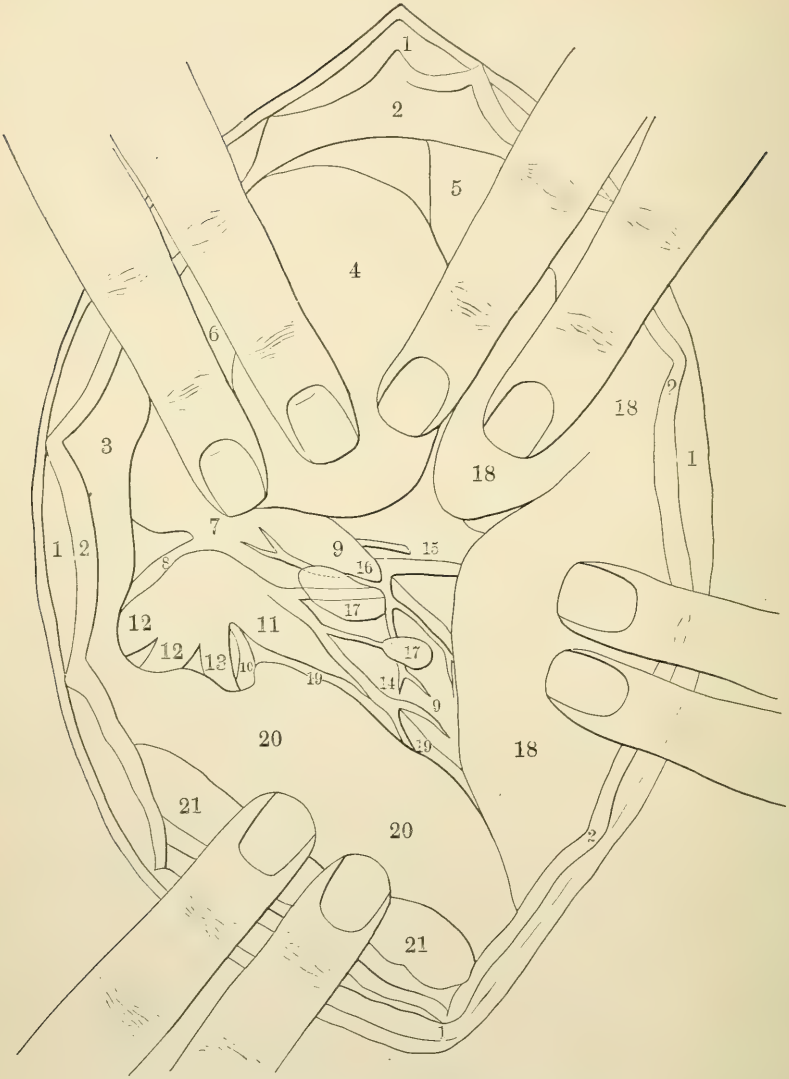
Rydygier prefers to perform thoracotomy first, because the external wound almost always opens the pleural cavity, and the wound in the diaphragm is more accessible from this side, and because the negative pressure in the pleural cavity is overcome as soon as this is opened. This negative pressure frequently renders it difficult or even impossible to reduce the hernia. (Naumann.)

In most of the cases it will be found sufficient to resect about 10 cm. of the rib immediately beneath the wound. Postemsky recommends osteoplastic resection of a U-shaped flap with the base upward, and divides from two to four ribs in two places. Rydygier endeavors

to avoid dividing the artery twice by cutting through the ribs to the outer side and turning the flap back, using the costal cartilages as a hinge. This can be done only in very youthful individuals with elastic chest-walls; and besides this, this method furnishes access only to the anterior side of the diaphragm. If on operation it is discovered that some abdominal organ has also been injured, then a laparotomy becomes necessary. When operating on a strangulated hernia, abdominal section will be sufficient only when the operation is undertaken within a very short time after strangulation has occurred. If there is any possibility that the incarcerated viscus has become gangrenous, then the chest should be opened and the strangulated structure freely exposed.

After replacing the prolapsed or strangulated intestines the wound in the diaphragm should be closed by several layers of sutures. The suture itself will for some time be a source of worry. It has been shown by experimental work that wounds which divide the muscle-fibres transversely are very apt to break open again with any slight increase in pressure, and that the hernia then reappears. Scalzi has reported clinical observations which bear out this experimental work. For this reason certain authors recommend that the wound should be closed by sewing the stomach to the margins of the opening. (Horoch.) Up to the present time no radical operation has ever been performed for non-strangulated hernia in this region, although an operation is indicated provided the diagnosis is certain.

Key to Plate XVI.



Relations of the Biliary Passages (Fenger).

1. Wound through abdominal wall. 2. Parietal peritoneum sutured to skin. 3. Right lobe of liver, lower surface. 4. Quadrate lobe of liver. 5. Suspensory ligament of liver 6. Gall-bladder. 7. Cystic duct. 8. Hepatic duct. 9. Common duct. 10. Branch of hepatic duct to lobus Spigelii. 11. Trunk of vena porta. 12. Branches of vena porta to right lobe. 13. Branches of vena porta to lobus Spigelii. 14. Small branch of vena porta in hepatico-duodenal ligament. 15. Hepatic artery. 16. Branches of hepatic artery to hepatico-duodenal ligament. 17. Lymph glands in hepatico-duodenal ligament. 18. Duodenum. 19. Entrance to foramen of Winslow. 20. Hepatico-colic ligament. 21. Transverse colon.

PLATE XVI.

INJURIES AND DISEASES OF THE LIVER AND BILIARY PASSAGES.

By Prof. H. KEHR.

Topographical Anatomy.—The relations of the liver to the right pleural cavity, the arrangement of the ligaments of the liver, and the best routes for reaching disease processes in different portions of the liver, should be understood by every abdominal surgeon. The left lobe of the liver lies relatively free in the mesogastric and hypochondriac regions, and is therefore more accessible than the right lobe, which is covered by ribs and the convex surface of the diaphragm. The suspensory ligament which separates the right and left lobes is a reduplication of the peritoneum from the diaphragm to the upper surface of the liver. It fastens the liver to the diaphragm and anterior abdominal wall. As it is placed in a sagittal plane, it separates the portion of the peritoneal cavity between the liver and diaphragm into a right and a left pocket, a point of pathological importance, as inflammation existing in one of these pockets rarely passes into the other. The portion of the suspensory ligament which extends from the umbilicus to the under surface of the liver is called the round ligament. When this ligament is divided, the motion upward of the liver is considerably increased and operations on its under surface are thereby facilitated. The gall-bladder and biliary passages are attached to the under surface of the right lobe. These structures are described further on.

It is important to know how far the right pleura extends in front, at the side, and behind. In other words, how much of the ribs and cartilages can be cut away to expose the liver without opening the pleural cavity. The cartilage of the seventh rib is almost always beyond the pleural cavity. This is true of the cartilages and a portion of the bones of the lower ribs from the eighth to the twelfth. The distance not covered with pleura increases on each successive rib until on the twelfth it is about 6 cm. (2.4 inches). The margin of the pleura crosses the right mammary line at the lower border of the sixth costal cartilage, and the anterior axillary line at the lower border of the ninth cartilage. From here it extends to about the middle of the twelfth rib. In order to expose the convex surface of the liver it is necessary to open the complementary space of the right pleural cavity. If the liver contains an abscess or suppurating echinococcus cyst, this portion of the pleural cavity is usually obliterated. Through an abdominal wound the lower surface of the liver and the anterior margin are easily accessible. The anterior surface is reached with difficulty unless one removes the costal cartilages which lie beyond the reflection of the pleura.

CHAPTER XXIII.

INJURIES OF THE LIVER AND BILE-DUCTS.

INJURIES OF THE LIVER.

Pathological Anatomy.—Holm, in 1867, made experiments to show the process of repair in wounds of the liver. Others have experimented with the same object, and surgeons owe their present knowledge to them, but especially to Ponfick, who demonstrated that three-fourths of the liver of an animal may be removed without serious injury. This loss is made good by hyperplastic and hypertrophic changes in the remnant of the organ.

There are three forms of subcutaneous injury to be considered: 1. Rupture of the hepatic tissue combined with tears in the capsule. 2. Separation of the capsule with subcapsular hæmatoma. 3. Central ruptures which often give rise to separate or united hæmatomata which may develop into cysts or abscesses. Peripheral injuries if recovered from usually produce adhesions to the neighboring organs.

Rupture of the liver following contusion is six times as common in the right as in the left lobe, and is twice as common on the convex as on the concave surface. The fissures may be superficial or deep, single or multiple, stellate, gaping, irregular, etc. A portion of the liver may be entirely separated and be found loose in the peritoneal cavity.

The severest degree of injury to the liver is the complete crushing of a portion of its substance. Such an injury is associated with fractures of the rib, injury of the lung or heart, fracture of the skull, etc. In rupture of the liver the hepatic cells may enter the venous current and set up pulmonary embolism. Stab-wounds and incised wounds of the liver are followed by severe hemorrhage. Such may or may not be the case with gunshot-wounds.

Etiology.—The size and firmness of the liver and its position between the ribs and vertebral column expose it to injuries. It has scarcely any elastic fibres, and is not compressible, so that when crushed it ruptures far more frequently than the other abdominal glands. Such injury may take place without any mark upon the external skin. The liver may even be torn by a fall from a height upon the feet, the sudden jar dragging the heavy organ away from its suspensory ligament. But the usual cause of subcutaneous injury is a crush of the body beneath a wagon-wheel or other heavy object, or a blow. The changes in the organ produced by tuberculosis, syphilis, and amyloid degeneration favor rupture of the liver.

Symptoms.—The early symptoms of rupture of the liver do not differ from those following injury to other abdominal organs. There is no single pathognomonic symptom of rupture of the liver. Cases are recorded in which shock and collapse and other marked symptoms were wholly wanting in spite of rupture of the liver so severe as to cause the patient's death in a short time. Such accidents are, however, exceptions. There are usually signs of internal hemorrhage, the blood collecting in the right side of the abdomen. The flow of blood toward the pelvis is interrupted by the mesentery and the cæcum, so that the blood may not appear in the iliac fossa or pelvis, but the exact situation of the blood is a sign of no great practical value. The character of the accident may indicate the organ which is injured. If the hemorrhage continues, the patient becomes anæmic, restless, and complains of intense local pain as well as diffuse abdominal pain. Sometimes, but not always, pain is referred to the right shoulder. In about 20 per cent. of the cases icterus develops some three or four days after the injury, on account of resorption of bile which has escaped into the peritoneal cavity. Urobilin may be increased. Occasionally glycosuria has been noted. Biliousness, vomiting, hiccough, and contraction of the abdominal muscles, are symptoms not peculiar to rupture of the liver. Pain caused by deep breathing and painful cough are symptoms which may also be due to fracture of the ribs, or injury of the diaphragm or lung.

If the wound is an open one, the hemorrhage is usually profuse. The blood streams out as from an angioma which has been cut into. A flow of bile from the wound often takes place five or six days later when the superficial layer of necrosis separates from the healthy tissue. In other respects the symptoms of an open wound are essentially those of a contusion.

Diagnosis.—It is apparent that in many cases it is impossible to say positively whether or not the liver has been injured, and yet this is an injury the proper treatment of which requires early diagnosis. It is therefore desirable to obtain an exact description of the way in which the patient was injured, and in case the right side of the thorax or abdomen was crushed, the possibility of injury of the liver should be uppermost in the mind. Only in rare instances has it been possible to palpate a fissure of the liver through the abdominal wall. Ordinarily the surgeon must content himself with the diagnosis of internal hemorrhage, and must ascertain the source of the bleeding at operation.

Prognosis.—Formerly the prognosis of injuries of the liver was considered hopeless, but since the introduction of aseptic methods of operating life may be saved in many cases. It should not be forgotten that infection may be added to the hemorrhage, bacteria reaching the wound through the portal circulation, or, more often, perhaps, through the biliary tract, since a healthy intestinal wall, as shown by experiments, does not permit the passage of any bacteria. A serious complication of extensive rupture of the liver, and one from which the late President Carnot suffered, is injury of the portal vein. It is con-

ceivable that a wound of this vessel might be stopped by tampons or suture, as has been done in cases in which it has been accidentally cut or torn during operation.

In the last ten years a number of cases of successful treatment of gunshot- and stab-wounds of the liver have been reported. Some of the published lists show a recovery in more than half of the cases. This is doubtless too high on account of the tendency of surgeons to report their successes rather than their failures. But still if the hemorrhage is not exhaustive and there are no serious complications the prognosis is relatively favorable. From 1896 to 1901 Terrier and Auvray collected records of 42 operations with a mortality of 24 per cent. They found that incised and stab-wounds had a mortality of 11 per cent., subcutaneous ruptures a mortality of 30 per cent., and gunshot-wounds a mortality of 36 per cent. These results, excepting those following gunshot-wounds, are considerably better than those following operations performed before 1896. The improvement is due rather to earlier diagnosis than to changes in the technic of operating.

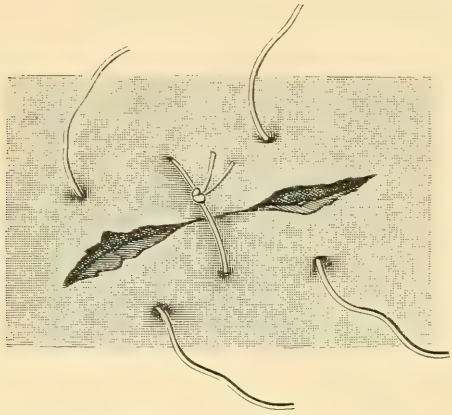
Treatment.—In open wounds of the liver, whether caused by a bullet or a knife, it is generally agreed that the abdomen should be opened to control hemorrhage and to prevent infection.

In subcutaneous ruptures it is more difficult to decide whether immediate operation is indicated. It cannot be disputed that extensive ruptures of the liver have been recovered from spontaneously. Still, if one decides to postpone operation until there are well-marked symptoms of hemorrhage or peritonitis, many lives will be lost which might otherwise be saved. The wisest plan is to operate not only when the diagnosis is a certain one, but also when the nature of the accident and the condition of the patient make it probable that the liver has been injured. An early exploratory incision is fully justified by Edler's statistics, which show that most patients with injury of the liver who die from hemorrhage do so in the first twenty-four hours. An exploratory incision carries with it little risk. It can easily be made with the help of a local anæsthetic and a view be obtained as to the condition of the liver and the presence or absence of blood in the general peritoneal cavity. If there is such hemorrhage, the patient can then be given a general anæsthetic, the incision extended, and the injured parts properly treated. The probable diagnosis will in most cases be found the correct one. Naturally, one would not operate in a case in which there was absolutely no sign suggestive of severe injury of the liver. Such a patient should be seen at frequent intervals and preparation made for operation so that it can be performed if necessary without delay.

If the external wound is a narrow one, it should be sufficiently enlarged to permit a satisfactory inspection of the liver. In case of gunshot-wounds a separate incision in the median line may be preferable. If the injury is subcutaneous, the incision should be made in the middle line, between the ensiform cartilage and the umbilicus. This incision gives free access to the left lobe. A transverse incision

through the right rectus muscle may be added to enable the surgeon to reach the right lobe of the liver. It is essential to expose the liver thoroughly even though the incision in the abdominal wall be a long one. Division of the round ligament and nicking of the coronary and

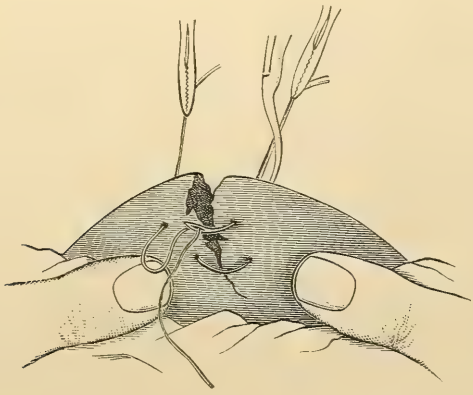
FIG. 304.



Suture of a rupture of the liver. (Lejars.)

triangular ligaments make the liver more movable and therefore more accessible. If the convex surface is wounded, resection of the costal cartilages may be necessary. (Compare the operation for subphrenic echinococcus, page 652.)

FIG. 305.



Suture of a rupture of the liver. (Lejars.)

If the wound in the liver itself is a simple one, it may be sutured. Deep stitches introduced with large curved needles to control hemorrhage should be supplemented by a superficial suture of the capsule. (Figs. 304 and 305.) The catgut or silk employed should be of good

size, so that it will not cut through. Suture of a healthy adult liver is not difficult. In childhood and after disease the tissue is very friable. Large vessels should be ligated directly or by means of an aneurism-needle. If the wound in the liver is very deep, it is best to combine tamponade with suture. When the hemorrhage is perfectly controlled, the abdominal wound may be sutured. A tampon delays recovery but reduces the risk, and is preferable to a suture in the treatment of gunshot- and punctured wounds since it is equally efficacious and is more quickly introduced.

If the liver is extensively crushed, suture is useless. The wound should be tamponed with sterile gauze.

Hemorrhage may sometimes be stopped by means of the thermo-cautery, but this treatment is unreliable in the case of large vessels and needs to be supplemented with tamponade. Several operators have reported good results from the use of steam as a hæmostatic.

Reasonable search should be made for wounds of the stomach, pancreas, kidney, etc. It should also be borne in mind that the liver may be ruptured in two or more places. Bits of clothing and other foreign bodies are likely to escape notice unless one operates directly through the enlarged wound. It is unwise to make a prolonged search for such objects. If blood or bile reaccumulates in the abdominal cavity, a second operation must be performed.

There is nothing peculiar in the after-treatment. A rise of temperature may be due to an abscess in the liver or in the subphrenic space, or to suppuration in the right pleural cavity.

INJURIES OF THE BILE-DUCTS.

Experiments upon animals have shown that the escape of bile into the peritoneal cavity produces violent symptoms but does not give rise to fatal peritonitis. If the bile remains for a considerable time a serofibrinous plastic peritonitis develops and all the intestine becomes covered with a fibrinous membrane which may be peeled off. As much as twenty kilos (quarts) of bile has been known to collect in the abdominal cavity.

If the gall-bladder is distended—for example, when the cystic duct is occluded by a calculus—it may be ruptured by a fall on the right side more easily than a normal bladder. In general the injuries which produce rupture of the liver may also produce rupture of the bile-ducts.

Rupture of the gall-bladder gives about the same symptoms as rupture of the liver, namely, collapse, pain in the right hypochondrium which may extend to the back and to the right shoulder, vomiting, and restlessness. In three or more days jaundice appears, due to absorption of bile from the peritoneal cavity. If the peritoneum is the seat of chronic inflammation, it may be incapable of resorbing bile, so that jaundice under such circumstances may not appear. As the bile in the peritoneal cavity increases, the abdomen becomes more

and more distended. The fluid which first escapes from a wound in the gall-bladder may contain considerable blood. The presence of a large percentage of bile indicates rupture of the biliary passages rather than that of the liver. Absence of bile-pigment from the stools suggests injury of the common duct rather than that of the gall-bladder.

Courvoisier mentions 34 cases of subcutaneous rupture of the biliary passages, with death in 22 of them. In 5 cases death occurred in thirty hours from collapse, and in the rest of the fatal cases it was due to fibrinous peritonitis and toxic action of the resorbed bile. He also reports 14 cases of penetrating wounds, with death in 3 cases from collapse and in 6 from sepsis. But since his time the prognosis has been somewhat improved by prompt aseptic treatment. It has been shown that bile escaping from healthy bile-ducts does not usually produce septic peritonitis. It is, however, a good culture-medium for the development of micro-organisms; and, furthermore, germs may pass from the duodenum into the common duct. If there is disease of the gall-bladder or other biliary passages, infection may develop when the bile escapes into the peritoneal cavity. The possibility of cholæmic intoxication, the result of resorption of bile by the peritoneum, must further be borne in mind.

Whenever a diagnosis of rupture of the bile-ducts is made, the abdomen should be opened. Some have advocated a transverse incision, some a longitudinal. The principal thing is to make an incision sufficiently large to permit free inspection. In cases of doubt a small exploratory incision should be made to confirm or correct the diagnosis.

If there is a small wound in the gall-bladder, its edges should be trimmed and approximated by a double row of sutures which do not include the mucous membrane. A stitch which penetrates the cavity of the gall-bladder may become the nucleus of a calculus. Formalin catgut is the best suture material for this purpose. If the gall-bladder is badly injured, it should be incised. If the cystic duct is wounded or torn across, it should be sutured or ligated. In the latter case the gall-bladder should be removed. If the common duct or hepatic duct is injured, the wound should be treated by a tampon of sterile gauze. While it is possible to suture a common duct which has been dilated by reason of the presence of a calculus, suture of a wound in a normal common duct is often difficult. A drain may be inserted into the hepatic duct so that the bile may be brought outside the body for a few days. In these cases the operator is often compelled to do what can be done quickly in order to save his patient. If the common duct is torn across, the patient may be treated by a cholecystenterostomy, but on account of the risk of infection from the intestine it is better to approximate the torn duct as nearly as possible and to treat the wound with a tampon of sterile gauze. Experience has shown that wounds in the common duct 3 or 4 cm. (1.2 or 1.6 inches) long, and even transverse divisions of the duct, may heal perfectly.

Extensive injuries of the gall-bladder and ruptures of the biliary

passages are commonly associated with injuries of the liver, the operations for the treatment of which are given above. There are often coexistent wounds of the intestine, pancreas, kidney, etc.

If an injury of the gall-bladder or bile-ducts is not recognized until the symptoms of collapse have passed off, and jaundice or fluid in the peritoneal cavity suggests it, recovery may follow repeated aspiration of the extravasated bile. The tear in the gall-bladder may heal spontaneously. However, if the strength of the patient permits it, it is better to make a short incision which will permit escape of the fluid and will at the same time enable the surgeon to inspect the biliary tract.

CHAPTER XXIV.

DISEASES OF THE LIVER.

ABSCESS OF THE LIVER.

Acute hepatitis, a disease more often seen in the tropics than in the temperate zone, frequently leads to abscess of the liver. It is thought to be due to micro-organisms which enter the liver from the intestine through the lymphatic or blood- or biliary vessels. The excessive use of alcohol, strong cathartics, etc., are considered predisposing factors in this disease. Be that as it may, white men are the chief sufferers from this affection, and these people, especially when only a short time in the tropics, are unwilling to content themselves with the simple and scanty fare of the natives. The tropical abscess of the liver follows dysentery in the majority of cases. Several observers have found the amœba of dysentery in the pus from the abscess. There are also instances in which hepatic abscess has followed malaria, influenza, and yellow fever.

This subject is of practical importance to physicians living in a temperate zone, since those who return home after a long stay in the tropics occasionally develop hepatic abscess. Sometimes a foreign body has been found in an abscess of the liver—fishbone, a bit of straw, etc. Abscess may also be due to contusion, the infection in such cases being introduced through the blood or biliary channels. In open wounds of the liver the infection may enter from without. Round worms may enter the biliary passages and set up abscess. Other agents are coccidia, the ray fungus of actinomycosis, and, in rare instances, the bacilli of tuberculosis. A syphilitic gumma of the liver may suppurate. Abscesses secondary to lesions of echinococcus and cholelithiasis are somewhat more common.

Any infectious disease, and especially typhoid fever, may set up suppurative cholelithiasis and cholangitis, which in turn may produce pericholecystitis, pericholangitis, suppurative thrombosis of the veins, and abscess of the liver. Ulcer of the stomach or duodenum may produce adhesions to the liver and break through its capsule, forming an abscess in the substance of the liver. Abscess of the kidney may act in a similar way.

The metastatic abscesses of pyæmia, some of which may occur in the liver, have little interest for the surgeon, as they are lesions of the last stage of this disease. Abscess of the liver which follows ulceration in some organ connected with the portal system is of greater sig-

nificance. As examples may be mentioned appendicitis, periproctitis, carcinomatous ulcer of the intestine, or, more rarely, of the stomach or of the pancreas. Such a process sets up suppurative thrombosis of the veins, which in turn produces septic emboli and abscesses in the liver. Gangrene of the lung, putrid bronchitis, and ulcerative endocarditis may be the source of septic emboli which reach the liver through the hepatic artery. Peripheral suppuration may produce emboli which pass the capillaries of the lungs and set up abscess in the liver. This fact has been variously explained. It is probable that parenchymatous swelling of the liver narrows its capillaries so that emboli which pass the capillaries of the lung are caught in the liver. It has sometimes been asserted that owing to the weak heart and limited abdominal resorption there is a back flow of blood from the vena cava into the hepatic vein, giving rise to septic embolism.

Pathological Anatomy.—Abscesses of the liver may occur singly or in groups. Zancarol found multiple abscesses in 38 per cent. of 211 cases; Jimenez, in only 6 per cent. of 297 cases. The pus frequently contains amœbæ. Giordano found it sterile in 58 per cent. of the cases, a proof that the micro-organisms in the course of time either die out or become scattered. Germs frequently found are staphylococcus aureus and albus, bacterium coli, and Fränkel's pneumococcus. The majority of abscesses of the liver develop in the right lobe and near the convex rather than the concave surface. Such an abscess may be of varying size. In rare cases it occupies almost the whole liver. As it develops it may break into the various neighboring organs or spaces. Tropical hepatic abscess is for the most part solitary, while metastatic abscesses of a pyæmic nature and those due to cholangitis are usually multiple.

Course of the Disease.—The development of a hepatic abscess varies according to the nature and origin of the infection. Tropical abscess grows slowly without marked symptoms. It may suddenly perforate into the colon, the stomach, lungs, or other viscera, with considerable relief to the patient, or into the vena cava, pericardium, or peritoneal cavity, producing sudden death. If abscess of the liver is secondary to dysentery, malaria, or echinococcus, its symptoms may be obscured by those of the primary disease for a long time. Spontaneous recovery is extremely rare, yet it may occur, the abscess becoming surrounded by a thick fibrous capsule and its contents being finally resorbed. Such a happy outcome is so rare that the prognosis of cases left to themselves is uniformly unfavorable, nor can one trust to rupture of an abscess into some hollow organ with spontaneous recovery. The prognosis even when operative treatment is employed varies according to the source of the disease, the presence of multiple abscess, the general condition of the patient, and other factors. Those writers who have reported a series of cases have usually placed the mortality of operation at 50 per cent. or even higher. The disease may be expected to last from three weeks to six months, or even longer if the walls of the abscess are very firm.

Symptoms.—Abscess of the liver may run its course without symptoms. Rouis says that the disease is latent in a third of the cases. The symptoms are often obscured by those of the primary disease of which the hepatic abscess is merely a complication. The characteristic group of symptoms, namely, fever, local pain, increased hepatic dulness, and tumor, were found in only 8 per cent. of Rouis's cases. Some authors cite as characteristic of the disease a tired, sad expression, a peculiar yellowish tint of the skin and eyes, not exactly like jaundice, and the position which the patient takes to relieve his pain by relaxing the right rectus muscle. The favorite position of the patient is upon his back with the right thigh somewhat flexed and the body bent toward the right side.

Pain may be wholly wanting in from 15 to 28 per cent. of the cases. If present, it may be constant, or may shoot to the right shoulder. If the abscess is near the surface of the liver, peritoneal friction-rub may be felt and heard. In chronic cases fever may be wanting. In acute cases the fever often takes on an intermittent type so that the disease may easily be mistaken for malaria or tuberculosis. Jaundice is not well marked unless the abscess compresses one of the larger bile-ducts. The liver is altered in shape according to the situation of the abscess. Sometimes the right lobe is very prominent in the right hypochondriac region. Abscess in the convex portion of the liver presses the diaphragm upward, while abscess in the concave portion reveals itself in the epigastrium. A very large abscess may so press upon the portal vein as to cause ascites or even to dilate the superficial veins of the abdominal wall (caput Medusæ). Circumscribed œdema of the back and infiltration are signs of threatened rupture through the abdominal wall. The digestion is usually disturbed. Abscess of the convexity of the liver often sets up serous or purulent exudation in the right pleural cavity. Rupture of an abscess of the liver produces different symptoms according to its situation so that it is scarcely worth while to describe them in detail.

Diagnosis.—If a single abscess develops in the centre of the liver, or if there are multiple small abscesses, the diagnosis is often difficult. A single abscess near the surface of the liver is more easily recognized. If amœbæ or coccidia are found in the stools of a patient who complains of pain in the hepatic region, the existence of an abscess is probable. If the other symptoms mentioned are present, and especially if there is fluctuation, the diagnosis is practically certain. The fluctuation of echinococcus is tense, that of abscess less so. Aspiration may be performed for the sake of diagnosis, but it carries with it a slight risk of hemorrhage and of infection of the peritoneal cavity. A short exploratory incision made under local anæsthesia is preferable. If pus is found, operation should be at once determined upon. Percussion is a help in diagnosis if the abscess is situated in the convex portion of the liver. Symptoms of indigestion, such as pain, vomiting, and diarrhœa, have little value in making the diagnosis of

liver abscess. If the lung is compressed, or the pleura is involved in the inflammation, there may be dyspnœa and cough. In making a differential diagnosis the following conditions must be considered: 1. Echinococcus and serous cysts of the liver, in which the tension is usually greater than in abscess. 2. Uronephrosis and pyonephrosis, to be recognized by the history, by the cystoscope, distention of the colon, etc. 3. Affections of the gall-bladder, such as empyema or hydrops; the history of the disease will often serve to distinguish these conditions, which can scarcely be mistaken for abscess if the gall-bladder is still movable. 4. Cysts of the pancreas, for the symptoms of which see page 733.

Treatment.—While beginning suppurative hepatitis is to be treated medicinally, an abscess of the liver when once it has formed is amenable only to surgical treatment. If the liver has become adherent to the parietal peritoneum, the treatment is relatively simple. If no such adhesions have formed, it is the duty of the surgeon to protect the peritoneal cavity from infection. The object of treatment is thorough drainage of the abscess. Drainage through a large trocar is not sufficient. It is true that the patient is saved the necessity of a general anæsthesia and an open operation, but the trocar does not always prevent the escape of pus into the peritoneal cavity. The tube may become blocked by bits of necrotic tissue or it may slip out of the abscess cavity. Jimenez, who treated 297 patients by puncture, lost 82 per cent. of them. If a general anæsthesia is feared, local anæsthesia will suffice for incision through the abdominal wall. If the liver is found adherent, the abscess cavity is readily opened with a sharp knife and can be explored with the finger, and any foreign body in it can be removed. A large tube should then be fixed in the abscess cavity, through which irrigation with normal salt solution is to be carried out and the wound dressed with sterile gauze. If there are no adhesions between the liver and parietal peritoneum and the condition of the patient permits of delay, the surgeon may fix the liver in the wound by means of a few sutures, or by the simple introduction of sterile gauze he may stimulate the formation of adhesions. In ten days, or much sooner if necessary, the abscess may be opened without infecting the peritoneal cavity, by means of a sharp knife or a Paquelin cautery. If the condition of the patient does not permit of delay, or if the abscess is so situated that it is possible to open it without passing through the peritoneal cavity, the operation may be completed at once. The site of incision in the liver should be surrounded by gauze and the greater portion of the pus aspirated through a large needle. The liver should then be fixed to the parietal peritoneum with a number of strong catgut or silk stitches. The cavity should then be opened and drained with a glass or rubber tube. To curette such a cavity promotes a profuse bleeding and in no wise hastens the healing. The dry aseptic dressing should be changed as often as it becomes saturated, or if fever reappears. Abscesses of the convex surface often require resection of the lower ribs, or they may be opened by the so-called transpleural

method. These operations are described in the following pages. When an abscess perforates into the pleural or peritoneal cavity, an immediate operation is indicated.

The abscess cavity when drained gradually fills with granulations, a process which takes six weeks, more or less, but the healing is by no means so slow as that after an operation for echinococcus. Irrigation is not usually of benefit. The drainage-tube should not be removed until active suppuration has ceased.

After incision tuberculous abscess of the liver may be treated by injections of iodoform emulsion. Large doses of potassium iodide should be given a patient after operation for hepatic actinomycosis.

TUMORS OF THE LIVER.

Tumors of the liver may be either cystic or solid. The latter are again divided into benign or malignant. Syphilis of the liver is also considered in this section because of its tendency to tumor formation.

Cystic Tumors of the Liver.

Cysts of the liver may be either parasitic or non-parasitic. In rare cases cysts have been found due to distoma hepaticum, lanceolatum, etc., psorosperms; but practically the only parasitic cyst of human interest is that due to echinococcus.

Echinococcus of the Liver.—An echinococcus cyst is the early development of tænia echinococcus, a tapeworm of three or four joints, measuring about 5 mm. (0.2 inch). This is found in the upper portion of the duodenum of dogs. If ripe seeds of this parasite find their way into the human stomach or intestine, they pass through the portal vein or the thoracic duct and lodge in the liver, lungs, kidneys, spleen, etc., and there develop. The ripe eggs may find their way into the human stomach through drinking-water, uncooked vegetables, etc., or the dog which is affected with them may lick a plate or the face of a man, etc. The domestic cat and the rabbit may also be the source of an echinococcus infection. Echinococcus is common in Iceland and in other cold countries in which men and dogs are closely housed together. When the embryo is deposited in the liver it develops very slowly, so that in five months it forms a cyst measuring only 2 cm. (0.8 inch) in diameter. It is surrounded by a connective-tissue capsule. Within this there is a true capsule of the cyst called the cuticle, yellowish or whitish, firm, and lined with a tender parenchyma, from whose cells the heads of the tapeworms, or scolices, develop. These are at first conical bodies united to the capsule by a slender pedicle. They are provided with suckers, surrounded by two rows of hooks. When fully developed, the scolices are separated from the parent membrane and float free in the cavity of the cyst. For a detailed description of the development of endogenous, exogenous, and multilocular forms of echinococcus the reader is referred to works on pathology.

The normal echinococcus fluid is colorless, clear, or slightly opalescent, and either neutral or slightly acid or slightly alkaline. Its specific gravity varies between 1.000 and 1.015. It contains no albumin and is not clouded by boiling or by contact with nitric acid. It contains sodium chloride, succinic acid, ptomaïns and toxins, which after repeated puncture of the cysts may leak into the peritoneal cavity and set up symptoms of general intoxication. A definite diagnosis of echinococcus can only be made from the fluid in case one finds on microscopical examination echinococcus hooks or portions of a cyst-wall.

Fig. 306.

Patient suffering from a large hydatid cyst of the liver. (Lancereaux.)

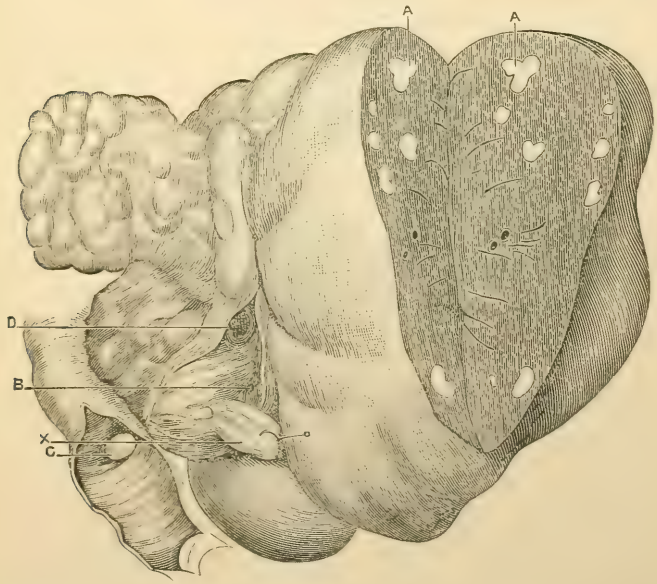
Special Pathology.—Usually one finds only a single echinococcus cyst in the liver, two or more being present according to Könitzer in 12.6 per cent. of the cases. The right lobe is usually affected. If the cyst is situated in the centre of the liver, the shape of the organ is little changed. It may undergo great changes if the cyst or cysts are near the periphery. In some instances, especially if the cyst is near the lower surface, the suspected portion of the liver may become pedicled, rendering diagnosis extremely difficult. Sometimes the cyst

FIG. 307.

Hydatid cyst of the upper portion of the liver and multiple cysts of the omentum. (Lancereaux.)

grows until it reaches the pelvis; or, if situated upon the upper surface, it may press the diaphragm upward until the right lung is reduced

FIG. 308.



Large hydatid cyst of the left lobe of the liver and multiple abscesses of the right lobe, *a*, *a*; *d*, cyst breaking into the common duct; *c*, ampulla of Vater. (Lancereaux.)

to the size of an egg. Usually, however, it produces a rounded swelling in the right hypochondrium or epigastrium, while the rest of the liver is unaltered. The tissue immediately over the cyst suffers

atrophy through compression, and compression of the larger biliary ducts may cause jaundice. This is a rare symptom, for the reason that the slow growth of the cyst permits the ducts to accommodate themselves to the altered relations. Traumatism may rupture the cyst. Bacteria may enter it and set up suppuration. The clear fluid in it will then be changed into a cloudy one and then into foul pus. The echinococcus may die before infection takes place. In such a case the cyst contracts and its contents calcify or change into a grumous fluid.

FIG. 309.

Hydatid cyst of the liver. (Francis H. Markoe.)

The cyst may press upon the portal vein and cause ascites, or it may press upon the vena cava; or it may interfere with the normal functions of the stomach or intestine. It may rupture into the pleural cavity and then into the bronchi with spontaneous recovery, or death, as the case may be. Perforation into the portal vein, the hepatic vein, the inferior vena cava, the hepatic artery or the pulmonary artery, into the pelvis of the kidney or the urinary bladder is rare. Perforation into a bile-duct is relatively more common. The cysts may be discharged through the common duct or they may block this up, giving the symptoms of stenosis. Sterile bile may terminate the life of the echinococcus without especial symptoms, whereas if infection is added there will be the usual symptoms of pain, fever, etc. Perforation into the stomach or intestine if preceded by adhesions is a favorable outcome. Perforation into the free peritoneal cavity is most

unfavorable. Perforation through the skin is the most favorable of all. An echinococcus cyst has been known to perforate in two directions.

Symptoms.—Echinococcus of the liver as long as it is small produces scarcely any symptoms. Pain is slight and jaundice is rarely seen. The patient begins to complain when the cyst is sufficiently large to press upon some neighboring organ. If the cyst suppurates, there will be chills and high fever, intense pain in the region of the liver, emaciation, and loss of strength. The cyst may from time to time press upon the kidney and produce an intermittent albuminuria. If the cyst presses against the diaphragm, there will be dyspnœa, cough, and a feeling of anxiety due to pressure upon the heart. Intense pain in the side and gasping for breath precede rupture into the pleural cavity. The result is an acute inflammation which is usually fatal, although spontaneous recovery may follow if the fluid perforates the lung and is discharged through the bronchi. If the lung becomes adherent to the diaphragm before perforation takes place, the symptoms will be those of chronic pneumonia, and a correct diagnosis will probably not be made until the cysts are coughed up. Such a patient may recover, but he runs the risk of death from suffocation in his attempts to cough up the cysts. Rupture into the peritoneal cavity produces speedy death if the cyst contents are purulent. If not, there will follow symptoms of poisoning due to the resorption of toxins and ptomaïns. The skin of such a patient breaks out in a rash similar to urticaria, a point of importance in the diagnosis. If adhesions have formed, so that the rupture is into a small cavity, the prognosis is more favorable. Rupture into the biliary passages produces cholangitis if the echinococcus cyst contains pus and its contents are not rapidly discharged into the intestine. Rupture into the stomach or intestine is preceded by the symptoms of circumscribed peritonitis, namely, pain, loss of appetite, and disturbances of digestion. If rupture occurs into the urinary passages, a cyst may stick in the ureter and cause obstruction. Rupture through the skin is characterized by the presence of tortuous fistulas which show little tendency to heal.

If the echinococcus dies, many of the symptoms may still persist.

Diagnosis.—Diagnosis of echinococcus cyst is impossible as long as the tumor is small. When the tumor is recognized, it appears connected with the liver, rounded, with a smooth surface, elastic, and possibly distinctly fluctuating. If the tension within the cyst is very high, fluctuation cannot be made out and the tumor appears solid. If there is no inflammation, there will be no tenderness on pressure. The tumor moves with respiration just as does the liver. It is completely dull on percussion, and if the patient is put in such a position that the abdominal muscles are relaxed, the situation, extent, mobility, consistence, and configuration of the tumor can usually be made out by palpation. The so-called hydatid tremor said to be characteristic of echinococcus is rarely found. Moreover, it may also occur in hydronephrosis, ascites, or cystosarcoma of the liver.

Echinococcus is differentiated with difficulty from cysts of a non-parasitic nature. An exploratory puncture has in many instances cleared the diagnosis, but this is a method which ought never to be resorted to. The tension in an echinococcus sac is so high that fluid may easily trickle into the peritoneal cavity through the opening made by the finest trocar. If the cyst is suppurating, peritonitis will speedily follow such an accident. Even if the cyst is sterile, puncture has been repeatedly followed by serious symptoms of poisoning produced by the toxins and the fluid, and by a general development of echinococcus cysts throughout the peritoneal cavity. For these reasons puncture should never be made; or it should at least be followed by immediate laparotomy.

The diagnosis of suppurating echinococcus is easy if the patient is known to have had a tumor with the characteristics of echinococcus before suppuration took place. The symptoms of pain, fever, and peritoneal irritation will then be added to those previously existing. The symptoms of inflammation are less marked if the tumor becomes adherent to the external abdominal wall and threatens to break through the skin; but even then redness and the peculiar condition of the skin and subcutaneous tissues and some general symptoms will reveal the true state of affairs. It should not be forgotten that when several cysts exist one may suppurate while the others still contain clear contents.

Abscess of the liver may usually be distinguished from suppurating echinococcus cyst by the history of previous colic and other symptoms due to gall-stones or traumatism. Carcinoma of the liver has a rough surface and feels harder than echinococcus. In fatty liver and amyloid disease the organ is uniformly enlarged and the history of the case will usually serve for a differentiation of these diseases. Hydrops of the gall-bladder produces a rounded tumor, but here too there will usually be a history of colic and symptoms due to gall-stones. A pedicled echinococcus cyst is most likely to be mistaken for a distended gall-bladder. Hydronephrosis or pyonephrosis of the right kidney is oval and extends well downward. Cysts of the spleen, pancreas, and mesentery have often been confounded with echinococcus of the liver, usually because of insufficient attention to the history of the case and the examination of the patient. An exact diagnosis is, moreover, not of the greatest importance since both conditions require treatment by laparotomy. Still, it is desirable to know the exact object of operation if possible before it is undertaken.

Subphrenic abscess and pleurisy with effusion are sometimes distinguished from subphrenic echinococcus with difficulty. In such circumstances exploratory puncture would be of great service, but for the reasons given above it is dangerous. If it is suspected that pus has collected either above or beneath the diaphragm, and puncture is necessary to confirm the diagnosis or to prove its correctness to the friends of the patient, this should be performed with aseptic precautions. If a clear fluid is obtained, operation should follow puncture

and the canula should be left in place. Meanwhile one should make it a practice to establish the diagnosis without puncture. Thus pleurisy develops suddenly with marked symptoms—fever, pain in the side, etc.; subphrenic echinococcus develops gradually and without marked symptoms. The pain of echinococcus is general in the whole right side, whereas that of pleurisy is well localized. The dyspnœa of echinococcus is constant; that of pleurisy exists only in the beginning of the affection. Pleurisy with effusion distends the whole side of the thorax, while the swelling of subphrenic echinococcus affects chiefly the lower portion of the chest. A pleural exudate fills the intercostal spaces and possibly causes them to bulge outward; this is never true of echinococcus. A pleural exudate presses the liver downward; the effect upon the liver of subphrenic echinococcus varies according to its situation: if it is posterior, the margin of the liver remains in its normal position. Finally, the course of echinococcus is a very slow one, while that of suppurative pleurisy is far more rapid.

If the suppurating echinococcus cyst is situated just beneath the diaphragm, it can easily be mistaken for a right pyothorax. A differential diagnosis between these two conditions is given under Subphrenic Abscess.

A distinction between subphrenic echinococcus and echinococcus within the pleural cavity is extremely important since the treatment is radically different. In the first place, the presence or absence of pleural exudate is to be determined. If the history shows there has been no acute attack, that dyspnœa is present and marked, that the respiratory murmur in the compressed lung is clearly vesicular and sharply differentiated from the area which is dull on percussion, and if the line between these areas does not alter with changes in the position of the patient, there is good reason to exclude exudate and to accept the diagnosis of echinococcus. If the disease is above the diaphragm, the distention of the thorax is more barrel-shaped rather than bell-shaped; the liver is pushed further downward and follows the motions of respiration more quickly than when the disease is below the diaphragm, since the action of the diaphragm is less interfered with.

If the echinococcus of the liver perforates into the peritoneal cavity, as a result usually of traumatism, the tumor disappears and there follow symptoms of intense peritoneal irritation (collapse, pain, fever, distention of the abdomen, etc.). If urticaria develops, the diagnosis is complete. If the patient survives the rupture, he may suffer from the development of echinococcus throughout the peritoneal cavity with the production of cystic tumors of varying size.

Echinococcus of the liver is a disease which may last from two to thirty years. Madelung believes that infection usually takes place in childhood even when the tumor does not become noticeable until adult life. The symptoms vary greatly according as the echinococcus maintains its vitality or dies, or the cyst suppurates, or ruptures. Rupture into the peritoneal cavity has a mortality of about 90 per cent.; that through the skin, a mortality of 10 per cent.; while the mortality of rupture

into the stomach or intestine lies between these extremes. Aside from the risk of rupture, echinococcus of the liver is a serous disease which constantly threatens the life of the patient, although the prognosis is good if an operation is performed in the early stages. The operation is simplified if the cyst has become very large and has produced atrophy of the overlying hepatic tissue; but this is not sufficient reason for delaying operation if the diagnosis is reasonably certain.

Treatment.—Aspiration and injection of antiseptics into the cyst, such as mercuric chloride, or 5 per cent. solution of formalin in glycerin, is a method of treatment which is at least as dangerous as an open operation. When the abdomen has been opened, the surgeon must decide whether he shall complete the operation or wait for adhesions to form between the visceral and parietal peritoneum. Complete operation at once is indicated when the cyst-wall can be sewed to the abdominal wall, when suppuration has greatly weakened the patient, and when there are multiple cysts. In general, an operation completed after adhesions have formed is less dangerous than one which is completed on the first occasion; but it prevents inspection of the abdominal cavity after the cyst is opened, so that a second cyst may be overlooked. For this reason, and because the risk of infection is slight when a proper technic is followed, most practised surgeons prefer operation completed at once.

Suture of the sac in the abdominal wound may lead to pain due to pulling upon the adhesions. It also predisposes to hernia in the cicatrix, and delays often for months complete healing of the wound. These disadvantages are avoided when the sac is wholly excised; but this and other radical methods (Billroth and Bobrow) have their own disadvantages.

The technic of operation performed in two steps is as follows: The patient should be prepared by laxatives and baths as for any laparotomy, unless there are present symptoms of peritoneal irritation. The abdominal incision should be made directly over the tumor, and should be sufficiently long to permit easy access. Most surgeons prefer a longitudinal incision. As soon as the peritoneal cavity is opened, the operator determines the size of the cyst, possible adhesions, the presence of other cysts, etc. Gauze is then placed between the visceral and parietal peritoneum in order to promote the formation of adhesions on all sides of the wound. The place at which the cyst is to be opened later should be marked by a superficially placed silk suture. A large gauze dressing is applied, the patient put to bed, and given a fluid or simple diet for ten days. The dressing is then removed and the adhesions examined. If they are insufficient, the dressing should be reapplied and the second operation postponed for a few days. When the adhesions are satisfactory, the cyst is opened with a sharp knife or a thermocautery. The liver should be supported during this procedure by two sharp hooks lest it tear away from the parietal peritoneum. The opening in the cyst is carefully enlarged, its cavity washed with normal salt solution, and any small cysts removed with forceps.

Gentle traction upon the parenchymatous lining of the sac will usually suffice to pull it out at the time of the first dressing. A continuous flow of bile is likely to follow its removal before it has had time to loosen. The cavity is drained with rubber tubes, and a large gauze dressing applied and changed as often as it becomes saturated with fluid. If the sac suppurates, it should be irrigated frequently. The tubes are to be gradually shortened as the cavity fills with granulations. The skin around the wound should be smeared with zinc salve to protect it from the irritating discharge.

When the operation is completed at once, the cyst may be stitched to the parietal peritoneum before it is opened or after it is opened. A good plan is to surround the exposed portion of the cyst with a wall of moist compresses, and to plunge a trocar into the cyst in order to evacuate as much as possible of its contents. The flabby wall is then incised, pierced with several tension sutures, and drawn well out of the wound. Its cavity should then be sponged dry, all daughter-cysts removed, and the edges of the incision in the sac sewed to those of the parietal peritoneum. The sac may then be irrigated with normal salt solution. Kehr has operated in 25 cases of echinococcus of the liver, usually according to the method last described, and has succeeded in every instance in keeping the peritoneal cavity free from infection.

Any cysts which lie close to the one already opened may be punctured and drained through the cavity of the latter. If they are placed at a distance, a second abdominal incision and separate suture are necessary. In every case one should determine by careful examination whether other cysts are present.

If an echinococcus cyst has already set up adhesions between the liver and parietal peritoneum, the operation for opening it is not more difficult than incision of any deep abscess. If an echinococcus cyst, even one which is suppurating, bursts into the peritoneal cavity, an attempt should be made to save the patient by a prompt laparotomy.

Recently more radical methods of treatment have been advocated. A cyst may be dissected or pulled out. This operation carries with it the risk of rupture of the cyst and that of subsequent hemorrhage or escape of bile. The latter danger can be lessened by the use of tampons. Still, in very many cases a pulling out of the cyst is technically difficult or impossible. Delbet pulls out the inner lining of the sac and closes the cavity by catgut sutures. This method is, of course, inapplicable if the patient has fever or other symptoms of suppuration. Billroth opens the peritoneal cavity, punctures, incises, and removes all daughter-cysts from the main cyst, cleanses the cavity of the latter, injects into it 30 to 50 grammes (1 to 2 ounces) of iodoform-glycerin and closes it carefully by suture. This operation is only permissible in case the sac is free from inflammation and is so situated that its cavity can be perfectly emptied and cleansed. The risk is considerable if one closes the abdominal wound without drainage. Bobrow operates by this method, but uses salt solution instead of iodoform-glycerin. These methods shorten the period of recovery to about three weeks, which is, of course,

a great advantage, but they carry with them a not inconsiderable risk of infection, and death in a few days. The operation is safer as performed by Rasumowsky, who when he has sutured the sac fixes it in the partially sutured abdominal wound. Terrier advocates a partial resection of the wall of the cyst together with the hepatic tissue which lies over it, so as to shorten the period of recovery. Such an operation carries with it a slight risk from hemorrhage.

If the echinococcus develops in the convex or in the posterior portion of the liver, it is best reached by the transpleural route advocated by Israel in 1879. He resects two ribs in the anterior axillary line and introduces gauze to obliterate that portion of the pleural cavity; or the layers of pleura may be sutured. Ten days later the diaphragm is incised, and if the echinococcus cyst has set up adhesions it may be opened at once, otherwise it should be surrounded with gauze and the operation completed at a still later date. Subphrenic echinococcus may also be reached through an abdominal incision if the liver is pushed downward according to Landau's method, or if the anterior portions of the cartilages of the eighth, ninth, tenth, and eleventh ribs are removed according to the method of Lannelongue.

Echinococcus cyst in the posterior portion of the right lobe may be reached through a lumbar incision, to which an anterior incision may often be added with advantage for the sake of orientation.

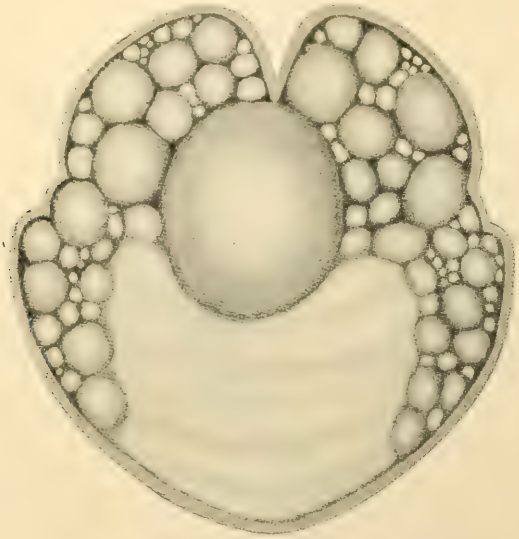
In the after-treatment hemorrhage sometimes occurs, and may be controlled by gauze packing or styptics. There is usually a moderate discharge of bile, but sometimes this amounts to a litre (quart) a day. The flow of bile has been ascribed by some writers to sloughing away of the connective-tissue sac and opening of the biliary ducts behind it, and by others to the presence within the sac itself of dilated bile-ducts which are either ruptured at the operation or by the sudden relief of pressure. If the sac suppurates and is cast off, the flow of bile is limited or prevented altogether, so that Vogt advocates giving up the aseptic dressing after a few days and allowing the wound to suppurate.

In many cases there is a communication between the echinococcus cyst and the biliary tract at the time of operation. After the operation such a perforation will usually close by granulation. If the discharge of bile continues for several months, this may be due to faulty granulation or to incrustation of some portion of the sac. Curettage may be followed by cure. Such a cure will be impossible if a larger bile-duct is obstructed by mucus, or a blood-clot, or a portion of echinococcus membrane, or a daughter-cyst, or a calculus, or the pressure of a deeply situated unopened echinococcus cyst or other tumor. By firmly packing the external fistula one may re-establish internal drainage; but if this fails, an operation must be performed to overcome the obstruction, or to get around it by anastomosis with the lower biliary tract or the intestine through the gall-bladder.

There are cases of multilocular echinococcus in which there are present a great number of small cysts embedded in a connective-tissue

stroma. (Fig. 310.) This is a modification of exogenous echinococcus, and is due to the proliferation outward of a primary cyst at the time when the latter is still small. If none of the cysts is large, the shape of the liver is not much changed. Its peritoneal coat is usually thickened and may be as hard as cartilage. Sometimes the tumor softens in its centre and a cavity is formed, which is filled with a fluid somewhat like pus. Multilocular echinococcus is almost always in the right lobe of the liver. The bile- and blood-vessels which are involved are obliterated or filled with the growing tumor. The central cavity may perforate into the gall-bladder. On section the tumor is whitish or greenish. The connective-tissue stroma often is calcified in places, and the numerous small cysts that are opened give the cut section an appearance similar to that of a sponge. It is not yet determined whether multilocular echinococcus is derived from the tapeworm of the dog or not.

FIG. 310.



Echinococcus cyst of the liver, showing parent and daughter-cyst. (Loux.)

In its earlier stage multilocular echinococcus produces slight symptoms and is diagnosticated with difficulty. It forms a hard tumor, proper treatment of which is radical excision. This can be carried out if the tumor is not too extensive and its edges are fairly well marked. If the whole of the tumor can be removed, the wound in the liver should be treated according to the principles given on page 636. Simple incision, curettage, and cauterization are not likely to effect a cure. A cure has followed ligation of the affected lobe of a liver, which was brought out of the wound and was removed after it had become gangrenous.

Non-parasitic Cysts of the Liver.—Congenital dermoid cysts are occasionally found in the liver, and may be removed by operation.

There are also multiple small cysts lined with epithelium of congenital origin, which possess little surgical interest as they cannot be treated by operation. They produce a cystic degeneration of the liver which often occurs in conjunction with cystic degeneration of the kidneys, ovaries, etc. The outcome is usually obstruction of the portal vein and death. If such cystic disease is found upon exploratory incision, the abdomen should be closed at once.

The cysts of the liver which are amenable to operative treatment are divided by Pellmann into five classes: 1. Retention-cysts of the biliary tract. 2. Cysts lined with ciliated epithelium, said by Recklinghausen to be due to mucus retention. 3. Dermoid cysts. 4. Epithelial cysts, or cystadenomata. 5. Lymph-cysts.

Symptoms.—The symptoms produced by one of these cysts are similar to those caused by an echinococcus cyst. A cyst of the liver may attain such a size as to be mistaken for a cyst of the ovary, kidney, etc., and without aspiration it is impossible to differentiate non-parasitic from echinococcus cysts. As stated above, puncture for purposes of diagnosis ought never to be performed. At operation a portion of the cyst-wall should be removed for microscopical examination.

Treatment.—The proper treatment consists in incision and removal of as much as possible of the cyst-wall. If the cyst is pedicled, its complete removal is possible, and many cysts which are deeply buried in the tissue of the liver may be shelled out. By this means a tedious and possibly permanent sinus may be avoided. Most of these cysts have a thicker wall than an echinococcus cyst, so that this shelling out is less difficult than is the case with echinococcus. Furthermore, the escape of cyst contents into the abdominal cavity does not carry with it the same risk as when one is treating an echinococcus cyst. The technic of operation and the after-treatment are the same as those given in connection with echinococcus cyst.

Solid Tumors of the Liver.

Syphiloma.—The surgeon is interested in only two forms of syphilis of the liver. These are the circumscribed gumma of the liver and syphilitic lobulation of the liver. A gumma of the liver is usually a single tumor, varying in size from that of a pea to that of a hen's egg, and usually occurring in one of two situations: near the suspensory ligament or near the entrance of the portal vein into the liver. Lobulation of the liver results from cicatricial contraction following syphilitic nodules. (Fig. 311.) The first symptoms arise when the affected portion of the liver begins to move independently in the abdominal cavity, and produce symptoms similar to those of a floating kidney. Ascites may also be present, due to diffuse disease in the neighborhood of the portal vein, or to pressure upon the portal vein by syphilitic tumors. Icterus is rarely present.

A large syphiloma of the liver is rarely correctly diagnosticated.

It is not difficult to determine that the tumor is connected with the liver even though its syphilitic nature is overlooked. If the patient gives a history of syphilis, a short course of treatment will serve to distinguish a syphiloma from a carcinoma. Sometimes diagnosis becomes clear when the abdomen is opened, but often the microscopical examination of a portion of the tumor is necessary. If during operation it becomes evident that a syphilitic tumor of the liver exists, the operation should be discontinued whether the tumor is pedicled or not, since the favorable effect of antisyphilitic remedies in this class of cases is very striking. If there is doubt as to the nature of the trouble, the tumor may be sutured in the abdominal wound.

FIG. 311.

Syphilitic enlargement of the liver and spleen: multiple gummata of the liver; laparotomy and removal of one tumor for examination; cure by subsequent treatment (drawn from life).

Adenoma.—Some benign tumors of the liver are harmless and demand operation only if their great size causes the patient discomfort. Such are fibroma, fibromyoma, and angioma. Adenoma is of significance, since it possesses some of the characteristics of malignant growths. Two kinds of adenomata of the liver are recognized:

a. Nodular hyperplasia, in which the hepatic cells have multiplied in an irregular way.

b. Tubular adenoma, in which the cells in their multiplication simulate tubular glands.

Several surgeons have reported successful operation for adenoma of the liver. In such cases the tumor has been large and surrounded by a distinct capsule. Sometimes hemorrhage occurs in the centre of an adenoma, so that at operation the tumor resembles a blood-cyst. The centre may also soften. True cystic degeneration of an adenoma is rarely seen.

Carcinoma.—Secondary carcinoma is much commoner in the liver than primary carcinoma. The former cannot be treated surgically.

If a primary carcinoma can be diagnosticated sufficiently early—for example, through an exploratory incision—it is conceivable that it may be removed with success. As a rule it causes such slight symptoms that it is not noticed by the patient until it is large enough to be palpated through the abdominal walls, and by that time loss of appetite and disturbances of digestion are already present. The time for operation has then gone by.

In the secondary form of the disease nodules of various size are scattered throughout the liver, while in carcinoma developing primarily in the liver there is usually a single solid tumor of a more or less spherical shape, while the hepatic tissue outside the tumor is little altered. There are also rare instances of multiple primary carcinoma and also an infiltrating type of carcinoma.

Primary carcinoma usually develops in the right lobe. It may undergo cystic degeneration and give rise to hemorrhages in the hepatic tissue. The disease has no surgical interest unless it can be seen early. The first symptoms of primary carcinoma are a loss of appetite and dislike of flesh and fatty food. But these symptoms are so little characteristic that the diagnosis will scarcely be made until a hard round tumor is felt. If jaundice or ascites is present, operation is not likely to be of benefit.

A few instances of successful operation for primary carcinoma of the liver are on record. In a series of 800 laparotomies performed for disease of the liver, biliary passages, and stomach, Kehr saw only 1 case of primary carcinoma of the liver at a stage when cure by radical operation might even be hoped for.

Operation for Tumor of the Liver.—Excision of a carcinoma of the liver may be dangerous on account of the hemorrhage occurring at the time, or on account of post-operative hemorrhage. If the tumor is situated in the left lobe, an elastic ligature can be employed to make the operation almost bloodless. The right lobe may occasionally be treated in the same way. Langenbuch recommends temporary ligation of the mesenteric artery and temporary ligation *en masse* of the hepatic artery, portal vein, and common duct by passing a ligature through the foramen of Winslow.

The technic of operations for tumors of the liver has been greatly improved in the last few years. It is a matter of indifference whether the incision is transverse or longitudinal. The operator should give himself sufficient room for the work in hand. If the tumor lies on the upper surface of the liver, resection of so much of the cartilages of the eighth to the eleventh ribs as is not covered with pleura will be necessary. Micheli's thoraco-abdominal flap may be of service. The more of a pedicle the tumor possesses the easier the operation. The pedicle should be ligated in sections, and larger single vessels should be separately ligated. Some surgeons always employ in addition gauze tamponade, because of the risk of post-operative hemorrhage. This plan is advisable in most cases. If the hemorrhage is imperfectly controlled and the stump is so situated that it can be

brought into the abdominal wound, it is well to fix it there with sutures so as to make it extraperitoneal. The stump should be sutured to the parietal peritoneum or possibly to the transverse fascia to facilitate the ultimate closure of the wound. If the tumor is not pedicled, the cavity left when it is shelled out of the hepatic tissue may be partially closed by deep stitches. Tamponade will also be necessary. Tillmanns advises in such cases fixation of the tumor in the abdominal wound and its removal at a later date when firm adhesions have formed. But this procedure is not to be recommended.

Kuznezow has recommended a method which successfully controls hemorrhage. He passes long blunt needles carefully through the hepatic tissue, thus avoiding puncture of the large vessels. The ligatures are tied and then the incision is made. If one proceeds in this manner step by step, the operation is well nigh free from hemorrhage. Of course, a carcinoma should not be shelled out of its bed, but excised by a cut passing well away from its margin. Experience has shown that a Paquelin cautery does not control hemorrhage as well as gauze pressure kept up for some time. Some Russian surgeons use steam as a hæmostatic in operations upon the liver.

Sarcoma.—Sarcoma of the liver is still rarer than carcinoma. Only a few cases have been reported of primary sarcoma treated by operation.

Aneurism of the Hepatic Artery.—Aneurism of the hepatic artery is a condition which, so far as known, has never been operated upon. The symptoms resemble those of gall-stone (pain and jaundice) or those of ulcer of the stomach or duodenum (vomiting of blood, or bloody stools). If a pulsating tumor giving a murmur is present, the abdomen should be opened and the vessel ligated either on both sides of the aneurism or at least on the proximal side. Such an aneurism usually develops outside of the liver, so that an operation of this character is feasible.

PARTIAL AND TOTAL HEPATOPTOSIS.

Partial Hepatoptosis.—Partial hepatoptosis is due to a constriction of the liver, usually a result of tight clothing. It may exist to such a degree that the two portions of the liver are united simply by a bridge of fibrous tissue. This condition is more often seen in the right lobe than in the left. Sometimes there is obstruction to the flow of blood through this fibrous bridge. The liver then becomes very painful, and symptoms of peritoneal irritation, such as vomiting and collapse, develop. As a result of chronic venous obstruction, the lobe may become more and more filled with fibrous tissue until it resembles a hard tumor.

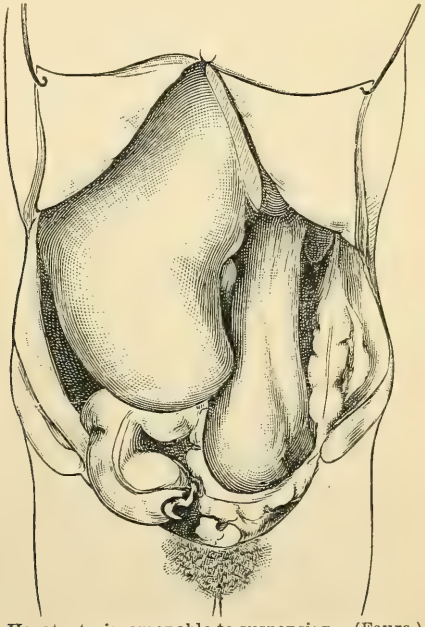
Symptoms.—The symptoms of partial hepatoptosis are local pain, which may extend upward to the breast or downward into the thigh, loss of appetite, and disturbances of digestion. In other cases there

may be no abnormal symptoms. Jaundice is rarely seen. If the left lobe is affected, it may press upon the pyloric portion of the stomach and so give rise to unpleasant symptoms.

Partial hepatoptosis is far commoner among women than among men. An examination will show that the tumor is intimately connected with the liver even though it possess a certain amount of mobility. If the mobility is considerable, the lobe may easily be confounded with other tumors of the abdomen. The chief points of diagnosis are as follows:

1. An enlargement of the liver, and especially of its right lobe downward, perhaps as far as the ileocæcal region.

FIG. 312.



Hepatoptosis, amenable to suspension. (Faure.)

2. An increased consistence of the constricted lobe owing to the thickening of its capsule and fibrous induration of its parenchyma.

3. The horizontal groove which may be felt.

4. The mobility of the constricted lobe, which has been mistaken for a movable right kidney, for a tumor of the liver, or of the omentum, or of the mesentery, as well as for a distended gall-bladder.

Treatment.—A properly fitting bandage will often relieve all symptoms. If this fails, operation is indicated. A number of surgeons have reported successful suture of the lobe to the abdominal wall; or, suture may be combined with tamponade. This operation, which is spoken of as hepatopexy, is not always successful, and some surgeons have been compelled to resect the movable lobe in order to cure their

patients. Such operation is rather to be advised if the tissue of the lobe is greatly altered or if it suggests tumor formation. The fibrous bridge which connects the lobe to the rest of the liver can be ligated in sections and divided, so that hemorrhage can easily be avoided. If there is any risk of post-operative hemorrhage, the abdominal wound should not be entirely closed, so that a tampon may reach to the wound in the liver. This method of treatment is preferable to suture of the stump in the abdominal wound, for the traction of the liver upon the adhesions thus caused may produce unpleasant symptoms. In certain cases it may be advisable to adopt Rydygier's treatment for wandering spleen—that is, to make a pocket outside of the peritoneum into which the constricted lobe of the liver can be passed. Riedel describes a tongue-shaped process of the liver seen in cholecystitis, which is a rather frequent form of partial hepatoptosis. When the inflamed gall-bladder is opened and stitched in the abdominal wall, it is well to suture this tongue-shaped lobe at the same time to the parietal peritoneum.

Total Hepatoptosis.—If the liver is completely loosened from its normal close relation to the diaphragm, so that it is displaced downward and at the same time is freely movable, it is spoken of as a wandering liver. If it cannot be pushed back into its normal position on account of adhesions, etc., it is spoken of as a fixed, dislocated liver. This latter condition is rarely seen. Wandering liver occurs chiefly in women, and is variously ascribed to tight lacing, to the effects of childbearing, to traumatism, and to rapid emaciation. Langenbuch says that anomalies in umbilical vessels may produce congenital shortening of the round ligament, while any mechanical cause which produces a sudden or gradual strain upon the round ligament may lead to a wandering liver.

Total hepatoptosis is often accompanied with nephroptosis, gastroptosis, and enteroptosis, being, in short, a part of the general splanchnoptosis.

Symptoms.—The symptoms are due to pressure, tension, and perhaps kinking of some abdominal organs. If the condition develops suddenly, pain is more severe; and even if it develops slowly there may be colic similar to biliary colic. A dragging upon the pylorus may lead to gastric dilatation, and pressure upon the portal vein or upon the larger biliary ducts may produce ascites or icterus. Most of these patients suffer from hysteria and various nervous symptoms.

Diagnosis.—The diagnosis of wandering liver rests upon the presence in the lower abdomen of a mass corresponding to a displaced liver. The upper border of this body is separated from the right lung by a highly tympanitic zone which extends from the front well around to the side. The tumor unless held by adhesions is easily replaceable when the patient is lying down.

Prognosis.—The prognosis in hepatoptosis of a slight degree is good.

Treatment.—A properly fitting bandage, attention to diet, and judi-

ciously applied massage will often cause all symptoms to disappear. When such measures fail, operation is indicated; but the results of operation are so uncertain that it should not be too hastily performed. Langenbuch recommends division of the round ligament on the ground that it may be congenitally short, or because a dependent abdomen by pulling on the round ligament may drag down the liver. Several surgeons have reported success following suture of the liver to the costal cartilages, or the liver may be fixed by extensive tamponade introduced between it and the anterior abdominal wall. The lower edge of the liver may be brought out through the peritoneum into a pocket prepared for it (Rydygier's splenopexy).[1]

There is an anteflexion of the liver in which the liver turns forward upon its transverse axis. This is also observed in women who have been accustomed to lace their abdomens. The treatment is the same as that described above.

Recently attempts have been made to overcome the ascites which accompanies chronic hepatoptosis or atrophic cirrhosis of the liver by an increase in the collateral circulation between the portal system and the general venous system. Talma recommended stitching the omentum, and if necessary the spleen, to the parietal peritoneum, and a great many operations of this or a similar character have since been performed. There have been some successes and many failures. It is necessary that the cells of the liver should be still capable of performing their function if the operation is to be of lasting benefit. In the German Congress of Surgery, 1902, Bunge reported 79 cases of ascites treated by Talma's method, with 32 cures and 15 improvements, and 32 bad results.[2]

The best modification of Talma's operation is that suggested by Eiselsberg and Neumann, who carefully rub strip by strip the parietal peritoneum and suture to it the omentum. In this manner the omentum becomes adherent to the anterior abdominal wall throughout a wide area.

[1] These and other methods are described in detail by Bötticher in the Deutsche Zeitschrift für Chirurgie, 1900, vol. lvi., p. 252.

[2] See also Progressive Medicine, June, 1903, p. 118.

CHAPTER XXV.

SURGERY OF THE BILIARY PASSAGES.

Anatomical and Physiological Considerations.—The position of the gall-bladder and its relations to the external abdominal wall vary greatly. An incision beginning at the lower margin of the ninth costal margin and carried downward along the outer margin of the right rectus muscle directly exposes the normally placed gall-bladder. But the surgeon usually has to do with a pathologically altered gall-bladder, and must be prepared to find it displaced to the right or high up under the liver, or, less often, displaced to the median line, or even to the left side. Rarely the gall-bladder is found situated to the left of the round ligament, although situs transversus does not exist. In one such case the cystic duct opened into a narrow left hepatic duct which joined the normal right hepatic duct near the duodenum. Sometimes the gall-bladder is displaced downward and is found in the lumbar region or in the neighborhood of the cæcum. These changes in position are chiefly due to changes in form and size of the liver, but also to adhesions between the gall-bladder and intestine, by which the gall-bladder is dragged out of its normal position.

FIG. 313.

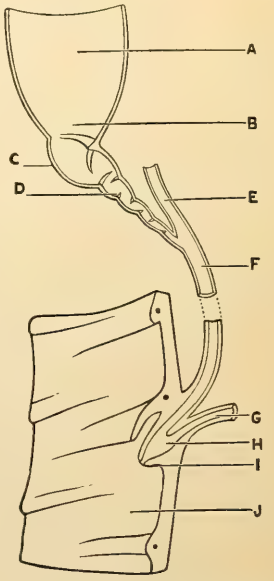


Diagram of the biliary passages: A, B, gall-bladder; C, D, cystic duct with valves; E, hepatic duct; F, common duct; G, pancreatic duct; H, ampulla of Vater; I, biliary papilla; J, second portion of the duodenum. (Testut.)

The size of the gall-bladder is as variable as its position. If the cystic duct is obstructed by a calculus, the bladder may be dilated until it is as large as a child's head, so that it may be mistaken for an ovarian tumor. It often shrinks, owing to inflammatory processes, until it is no larger than a cherry and is even found with difficulty.

It is unnecessary to describe the anatomical structure of the gall-bladder in detail. For surgical purposes it is sufficient to state that it is made up of a mucous membrane, a muscular layer, and a serous layer. Sometimes its wall is as thin as paper, so that every stitch which is passed into it penetrates its lumen. At other times the wall

is nearly half an inch thick and so hard that it can scarcely be cut with a knife.

The blood-supply of the gall-bladder is furnished by the cystic artery, a vessel which divides at the neck of the gall-bladder into two branches, one of which extends along the free side of the gall-bladder, and the other along the side of the gall-bladder next the liver.

The gall-bladder is more or less attached to the under surface of the liver, an attachment which is easily separated if it has never been strengthened by inflammatory processes.

There exists in the lumen of the cystic duct several folds called after the name of their discoverer, Heister. Their arrangement prevents in most cases the passage of a probe from the gall-bladder into the common duct. The probe usually passes into the diverticulum of the neck of the bladder rather than into the cystic duct. Indeed, Brewer goes so far as to say that a cystic duct which can be probed is a pathological one. But it does not follow that every duct which has been dilated by the passage of a calculus will allow the passage of a probe.

The cystic duct is often bent at a sharp angle as it enters the hepatic duct. At this point there is situated a lymphatic gland which when enlarged may easily be mistaken for a calculus. Other glands are situated along the common duct and portal vein, and their enlargement in inflammatory processes may mislead the surgeon who is not aware of their presence into thinking that the common duct contains calculi.

Both the cystic and common ducts are easily exposed if no adhesions are present. Adhesions may so change the normal relations that it is difficult for the surgeon to recognize these structures. As the gall-bladder is the guide both to the cystic and the common duct, this should first be found if possible, and followed to the cystic duct. The common duct extends from above downward and inward in the ligament between the liver and duodenum. It is easily exposed without disturbing the accompanying hepatic artery and portal vein if there are no adhesions. In the tissue covering the common duct there are a number of small veins and arteries with free transverse anastomoses which may give rise to troublesome hemorrhage when the common duct is cut into. Another guide to the common duct is the foramen of Winslow. If one passes a finger through this foramen, he can lift forward the common duct and so make it more accessible. Sometimes the foramen is obliterated by inflammatory processes. A third way of reaching the common duct, suggested by Langenbuch, is to locate the pylorus, and with it as a starting-point to search for the common duct. This method of approach is chiefly valuable in case the gall-bladder is so surrounded with adhesions that it cannot be found.

The common duct is conveniently divided into three portions, one of which is situated above the duodenum, one behind the duodenum, and one within the pancreas. The first portion is about 3 cm. (1.2 inches) in length, and is the most favorable part of the common duct for incision. The second portion may be reached after incision of the duodenum and exposure of the head of the pancreas.

There are numerous anatomical variations in the gall-bladder, such as the presence of two gall-bladders, or the absence of the gall-bladder, or obliteration of the cystic or other duct, but their description would occupy too much space. Such marked anomalies are rare.

Opinions differ as to the function of the gall-bladder. Murphy considers it a regulator of the tension within the biliary passages, like the air-chamber in a steam pump; others consider the gall-bladder a reservoir. Doubtless it has some special function, but its removal seems not in any way to affect a person's health or his digestion. If the cystic duct is removed together with the gall-bladder, there is no attempt on the part of nature to re-establish the original condition. If the cystic duct is left when the gall-bladder is removed, it may dilate so as to form a sort of gall-bladder.

Opinions in regard to jaundice vary even more widely than opinions as to the function of the gall-bladder. In diseases of the biliary passages there are two forms of icterus, as pointed out by Riedel: an inflammatory icterus and a lithogenous icterus. The first is due to swelling of the mucous membrane of the biliary passages, and may follow affections of the gall-bladder, since the swelling of the mucous membrane easily extends into the common and hepatic ducts and so interrupts the flow of bile. Lithogenous jaundice is due to obstruction of the common duct by a calculus. Jaundice of the first sort does not last long, and the color of the patient's skin is not deep. Jaundice of the second form may last a long time and be very intense. It is not always easy to differentiate between the two forms. Lithogenous jaundice varies from time to time, and seldom reaches the degree attained when the common duct is obstructed by a tumor. An inflammatory process which extends from the gall-bladder into the common duct involves also the pancreas, so that the jaundice which accompanies the presence of calculi in the gall-bladder is frequently due to obstruction of the common duct caused by a swelling of the pancreas. In acute cholecystitis there is also an acute swelling of the lymph-glands along the cystic and common ducts, and these may easily compress the common duct and produce icterus. Examination of gall-bladders which have been removed for acute cholecystitis shows that the inflammation usually terminates at the neck of the gall-bladder, and while the mucous membrane of the bladder is much swollen, that of the cystic duct is pale and little changed from its normal condition.

There are also acute inflammations in the biliary passages which, although not accompanied by the formation of calculi, may require surgical treatment. Such inflammation may be limited to the gall-bladder (cholecystitis) or to the larger ducts (cholangitis), or it may spread to the finer radicles of the biliary tract (diffuse cholangitis). The inflammation may be serous, fibrinous, purulent, gangrenous, or diphtheritic, and produce accordingly varying symptoms. There is a very acute form of cholecystitis which without perforation may set up general peritonitis. Gangrene of the gall-bladder is rarely observed

on account of its free blood-supply, not only through the cystic artery, but also through vessels which reach it from the liver. As long as the inflammation is confined to the gall-bladder the shape of the liver is not affected. In cholangitis the liver may be considerably enlarged. In cholecystitis pain and tenderness are limited to the region of the gall-bladder. The pain is often mistaken for gastric pain even though it is situated in the right hypochondrium. It may be severe and colicky in character, and extend to the back and right shoulder-blade. In cholangitis the pain is more diffuse, spreading over the whole region occupied by the liver. In cholecystitis jaundice is absent or slight. In cholangitis it is usually well marked. Fever is present with either disease, and in cholangitis it often assumes a septic or pyæmic character. Under the influence of inflammation the gall-bladder dilates; its muscular structure, and especially that of the neck, becomes hypertrophic, the serous coat thickens, and as a result there is a more or less palpable tumor, usually at the outer margin of the rectus muscle, whose lower outline is circular or elongated. Above, the tumor blends with the liver. If adhesions have not formed between the gall-bladder and the liver, there will be considerable motion of the organ from side to side, and sometimes from front to back. It will always resume its original position as soon as pressure is removed. It clearly moves with respiration, and it cannot be held down during expiration as can a floating kidney or a tumor of the stomach or intestine or omentum, all of which may move with respiration. The tumor formed by the distended gall-bladder may be so great that it is easily mistaken for hydronephrosis, cyst of the ovary, or echinococcus cyst of the liver. It contains either a pure serous fluid or a mucopurulent or purulent or even gangrenous fluid. Aspiration of the gall-bladder to determine the nature of its contents is under no circumstances justifiable.

According to the light of our present knowledge, inflammation of the biliary passages is due to the introduction into them of bacteria. It is hardly probable that a foreign body can produce inflammation without bacterial aid, although foreign bodies undoubtedly favor bacterial infection. Examples of foreign bodies are cherry-pits, parasites (such as echinococcus and round worms), and biliary calculi. Traumatism also plays its part in inflammation of the gall-bladder. There have been repeated instances in which some severe exertion has been followed by pain in the region of the gall-bladder, and in which at operation some time afterward there have been found extensive adhesions due to an acute cholecystitis or pericholecystitis. In some of these cases gall-stones may have existed at the time of the injury, but in others the inflammation developed without their aid. There are an acute cholecystitis and a purulent cholangitis which occur after typhoid fever, or cholera, or dysentery, or pyæmia, or gangrenous carcinoma of the gall-bladder, etc. Typhoid germs have been found in the contents of a gall-bladder some years after the patient has recovered from typhoid fever.

In all these inflammatory conditions cholecystotomy—that is, the

opening and suturing of the gall-bladder in the abdominal wound—may be indicated. In suppurative cholangitis drainage of the hepatic duct best rids the liver of the infected bile. Such treatment will only succeed in case the finer bile-ducts are not involved. It is not yet determined whether the leucocyte count is a reliable indication as to the severity of the inflammation. This in purulent conditions varies from 15,000 to 40,000.

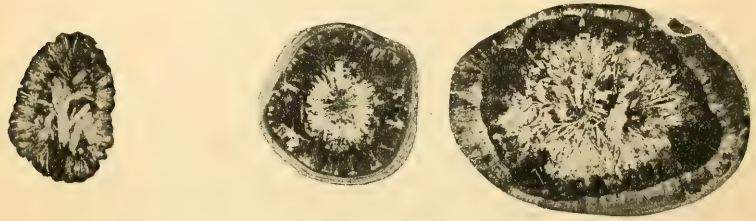
Tuberculosis and actinomycosis of the biliary passages are very rare diseases.

Surgical aid is occasionally demanded on account of traumatism of the gall-bladder or the biliary passages. Operation is much more frequently demanded on account of cholelithiasis and its sequelæ.

CHOLELITHIASIS.

Origin of Biliary Calculi.—Calculi are rarely found in young individuals. They are commoner in middle life, and they are frequent in later life. Women, especially if they have borne children, are more often affected than men (5 : 1). If a number of adult cadavers are examined, every tenth one will be found to contain calculi.

FIG. 314. FIG. 315. FIG. 316.



Gall-stones in section, natural size. (Naunyn.)

A biliary calculus may be composed of (1) pure cholesterin, (2) stratified cholesterin, (3) pure or mixed bilirubin and calcium salts, and (4) calcium salts. The size and number of calculi vary between wide limits. A solitary calculus is usually about the shape and size of a hazelnut or a walnut. (Figs. 314–316.) The size of the calculus and the amount of pain are in no wise intimately related. Accompanying inflammation or infection and the position of the stone in the neck of the gall-bladder or cystic duct or papilla of the duodenum are factors which determine the severity of symptoms far more than the size of the calculus. If several calculi lie in contact, their surfaces show facets. The color of a calculus is usually yellowish or brownish or black, but one which is composed of pure cholesterin is light and almost transparent. Sometimes the nucleus is a foreign body (an intestinal worm, a fruit kernel, part of a distoma hepaticum). Calculi have been known to form about silk threads which worked their way into the gall-bladder after operation.

Calculi rarely develop in any portion of the biliary tract except the gall-bladder. Their formation is favored by any influence which

obstructs the flow of bile, such as clothing, pregnancy, absence of abdominal respiration, muscular atony of old people, sedentary life, infrequent meals, etc. Riedel assigns to heredity an important part in their formation. Benecke believes they are favored by atheromatous degeneration and gout. Krauss ascribes importance to rich diet and luxurious living. Albers believes they are commoner among the poor, and Bouchard says there is an especial calculous diathesis.

It is beyond doubt that the formation of biliary calculi is favored by obstruction to the flow of bile. A catarrh of the biliary passages, and especially of the bladder, precedes their formation, and this catarrh is due, according to modern views, to an infection set up by bacteria which enter the biliary tract from the intestine (bacterium coli, typhoid bacilli, etc.). Fournier examined 100 biliary calculi and found living or dead bacteria in the centre of 38 of them.

Pathological Anatomy.—Calculi may exist in the gall-bladder without giving rise to symptoms as long as the cystic duct is open. In about 95 per cent. of the cases there is this latent period. When an inflammation of the gall-bladder takes place or the calculi come to lie where they interfere with the free flow of bile, the patient suffers from definite symptoms. The effect of the inflammation is to loosen the mucous membrane and produce a transudation of serous or purulent fluid. This inflammation, as already stated, may be serous, seropurulent, purulent, or gangrenous, and may lead to ulceration, perforation, etc. If the cystic duct is permanently closed by a calculus or cicatrix which follows an ulcer, and the inflammation subsides, a sterile hydrops of the bladder will be the result. If the infection continues, there will develop empyema of the gall-bladder. If the obstruction to the cystic duct is overcome by the passage of the calculus into the common duct or by a loosening of the calculus which was wedged into the neck of the gall-bladder, a cholelithiasis may be recovered from. But in most cases there will be recurrent attacks of inflammation because the presence of the calculus will keep up the infection and the gall-bladder will gradually lose the power to empty itself.

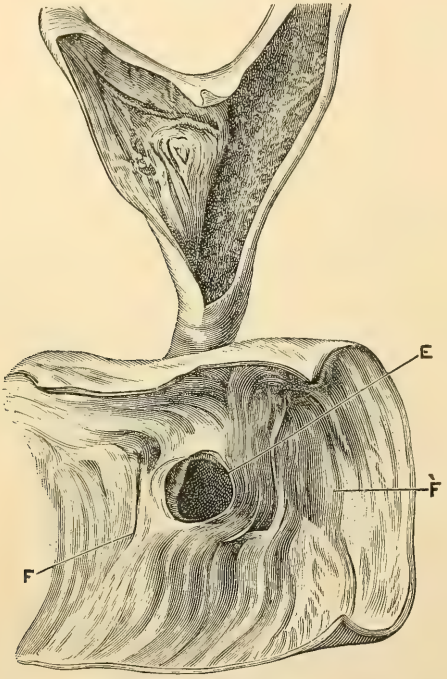
If the cholecystitis spreads to the serous coat of the gall-bladder, a pericholecystitis develops. The adhesions which result, by kinking the cystic duct, obstructing the flow of bile, and favoring the continuance of infection within the gall-bladder, may produce attacks of colic similar to those produced by a calculus even though all calculi have passed through the common duct into the intestine. In pericholecystitis the inflammation may extend to the pylorus and duodenum and produce new symptoms due to stenosis of these organs.

A spontaneous cure of cholecystitis by the complete discharge of calculi through the cystic and common ducts into the duodenum rarely occurs. A cure may rarely be effected by adhesions between the gall-bladder and intestine (duodenum, colon), perforation and discharge of calculi into the intestine. In rare cases the gall-bladder perforates into the stomach, urinary bladder, vagina, pelvis of the kidney or an ovarian cyst. Rupture of the gall-bladder and discharge through

the umbilicus are more often seen. Spontaneous cure which occurs in such a manner is apt to remain incomplete unless it is completed by the surgeon.

While the first effect of inflammation is to dilate the gall-bladder, its later effect is to contract it, and when once contracted it cannot again be dilated. Its walls are changed into cicatricial tissue, and then may even calcify. The cystic duct, whose calibre is normally very small, may become dilated by the passage of a calculus, and its muscular coats hypertrophy if a calculus remains in it for some time. If the calculus is finally passed, the duct contracts once more, or the scar following ulceration may obliterate it. These pathological changes may transform a normal tortuous duct into a perfectly straight passage.

FIG. 317.



Biliary calculus, E, lodged in the ampulla of Vater; seen from within the opened duodenum, F. (Baillie.)

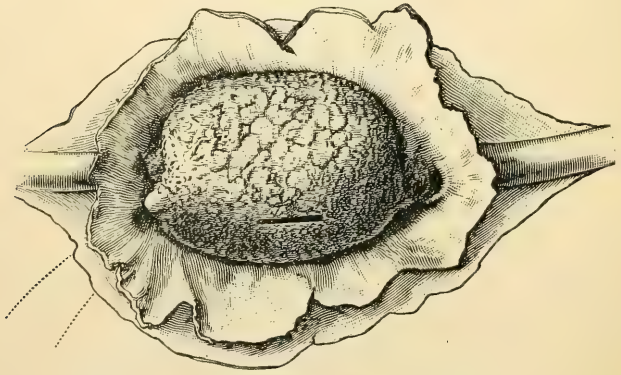
As long as a calculus remains in the gall-bladder or in the cystic duct jaundice is not likely to appear. This is true of 90 to 95 per cent. of the cases. Nor is the liver enlarged, except that the portion immediately over the gall-bladder may be stretched into a tongue-shaped lobe which has been confounded with movable kidney.

As soon as the calculus has passed from the cystic duct into the common duct jaundice develops and continues until the calculus passes through the papilla into the duodenum, or until the duct in which the calculus lies dilates and the flow of bile is again possible. The patho-

logical changes produced by a calculus in the common duct (Fig. 318) are essentially the same as those produced in the gall-bladder, viz., swelling of the mucous membrane and ulceration, although the latter rarely leads to cicatricial obliteration of the duct because the steady stream of bile prevents the walls from growing together. Frequently the common duct dilates to such an extent that the finger may be passed into it. Perforation may take place from the common duct into the stomach or duodenum, which gives a sort of spontaneous cure. A calculus which has lodged in the papilla (Fig. 317) is very apt to set up a fistula between the common duct and duodenum.

Inflammation in the common duct may extend to the tissues in its neighborhood, and it may produce thrombophlebitis, thus interfering with the circulation through the liver. It may easily lead to diffuse suppurative cholangitis and hepatic abscess. The inflammation may extend to the pancreas, giving rise to chronic interstitial pancreatitis, although a calculus in the common duct is more likely to produce

FIG. 318.



Calculus developing in the common bile-duct. (Doyen.)

serious results than one in the gall-bladder or cystic duct. Chronic obstruction of the common duct is often produced by a single calculus. In acute attacks there are frequently several lying one behind the other in the duct. The number of calculi in the gall-bladder may be very great, but it is by no means rare to find only a single calculus.

The colic which is characteristic of calculi has been variously ascribed to inflammation and to contraction of the muscles of the gall-bladder set up by irritation of the calculus. The former theory seems the more rational, and the possibility of inflammation should certainly be borne in mind by every physician who is called upon to treat a patient with biliary colic. This is not the place to discuss in detail the many complications of cholelithiasis, such as hepatic cirrhosis, nephritis, hepatic abscess, acute hemorrhagic endocarditis, meningitis, pulmonary abscess, pyæmia, etc. Carcinoma of the gall-bladder is almost certainly due to irritation of the mucous membrane by a biliary

calculus. The head of the pancreas may become so thickened as the result of inflammation extending to it from the biliary tract that it is changed to a firm tumor. Other local results of cholelithiasis are acute pancreatitis, disseminated fat-necrosis, and suppuration in the lesser peritoneal cavity.

The evil effects of more chronic inflammation are shown in Figs. 317 and 318.

Symptoms.—It follows from the varied pathological conditions which occur in cholelithiasis that the symptoms of this disease must be equally varied. Indeed, as long as the bile passes freely through the cystic duct into and out of the gall-bladder there need be no symptoms. If the cystic duct is obstructed, secretion will accumulate in the gall-bladder and hydrops will result. If the contents of the gall-bladder become infected, there will be symptoms of cholecystitis (tumor of the gall-bladder, pain, fever, circumscribed peritonitis). The more intense the infection, the more severe the general symptoms will be. Inflammation in a contracted gall-bladder does not give rise to palpable tumor. When the infection passes over, the tumor and other symptoms may entirely disappear, but usually there will be renewed attacks of inflammation with pain, etc. A calculus in the gall-bladder does not ordinarily produce changes in the liver, but such changes occur when the calculus enters the common duct. To the symptoms already mentioned there will be added jaundice, which if long continued produces cirrhosis of the liver and acts injuriously upon the blood-vessels (hemorrhages in cholæmia). A calculus in the gall-bladder does not usually produce fever. Fever is a common symptom when the calculus is lodged in the common duct, and there are often, too, disturbances of the function of the stomach and intestine (vomiting, loss of appetite, constipation or diarrhœa). Chronic obstruction of the common duct may so reduce the strength of the patient and produce such a cachexia that it is difficult to decide whether the obstruction is due to calculus or to carcinoma.

There are several points in connection with the diagnosis of cholelithiasis which are of such practical importance that it is worth while to group them together:

1. Jaundice is wanting in most cases of biliary colic since the latter is due usually to inflammation of the gall-bladder which does not involve the common duct. The idea that a calculus does not cause pain until it has left the gall-bladder is a mistake. Most attacks of colic are caused by calculi or inflammatory processes within the gall-bladder itself.

2. A calculus in the common duct, even though it is as large as a walnut, need not cause jaundice, because the duct dilates with the entrance of the calculus and bile may flow past it into the intestine.

3. The pain in biliary colic varies from a slight oppression to the most intense suffering. It may, however, be wholly absent both in empyema of the gall-bladder and in chronic obstruction of the common duct.

4. Examination of the patient in many cases gives only a negative result, and especially so if the gall-bladder is contracted, as it is apt to be in chronic obstruction of the common duct. The passage of biliary calculi at stool is a rare occurrence, because in most cases the calculi remain in the gall-bladder. Their entrance into the biliary passages is far less frequent than is generally supposed.

5. Perforation from the gall-bladder into the intestine may take place without pain, and with only slight fever.

6. A calculus may lie quietly in the common duct or hepatic duct without giving rise to symptoms. Even a calculus the size of a walnut may lie in the common duct without causing the patient any uneasiness. It may appear to obstruct the passage completely, and yet as long as there is no infection there may be no trace of jaundice even in the sclerotic coat of the eye.

Diagnosis.—In cholelithiasis it is not sufficient to say the patient has calculus; the surgeon should go further and determine the situation of the calculus and note what pathological changes may be present. Such exact diagnosis rests upon:

1. An exact history, including the record of previous attacks.
2. A careful inspection.
3. A thorough examination.

From a well-taken history one can often recognize the different steps in the pathological processes of cholelithiasis. The character of the attacks of colic, of fever, and of jaundice (if present) will often show the extent of the disease.

A careful inspection of the body gives the surgeon a mental picture of the relations of the affected organs so that frequently he can foresee the condition which he finds at operation. Inspection is the first step in the examination of the patient. A distended gall-bladder pushes the abdominal wall forward, and if the patient is thin it may be seen to rise and fall with respiration. If there is inflammation in the gall-bladder or around it, the upper portion of the abdomen may protrude more than the other portions.

Percussion will show whether the tumor which is felt is closely associated with the liver, but the results of percussion are somewhat unreliable. Auscultation is of even less value. A peritoneal friction-sound or clicking of the calculi together in the gall-bladder is rarely heard. Palpation, and especially bimanual palpation, is the most valuable means of diagnosis. The patient lies upon the back with the knees slightly flexed; the surgeon stands at the patient's right side, and places the left hand flat in the right lumbar region and the right hand over the gall-bladder. By pressure with the left hand the liver and gall-bladder are gently forced against the anterior abdominal wall so that they can be felt by the right hand without exciting contraction of the abdominal muscles. The tumor is almost always tender on pressure. This symptom may be wanting in cases of hydrops without infection. The surgeon next tests the mobility of the tumor in order to distinguish it from a wandering kidney. A distended

gall-bladder unless adherent may be pushed out of place, but always returns to its normal position. A movable kidney possesses a characteristic shape and it returns to its normal position with a peculiar little jump. When the colon is distended with air, a movable kidney almost always disappears, and a tumor of the gall-bladder is usually displaced upward. Tumors of the stomach may be recognized by chemical examination of the gastric contents or distention of the stomach with air. An echinococcus cyst which develops in the neighborhood of the gall-bladder may easily be confounded with a tumor of the gall-bladder, although a carefully taken history will show in most cases of echinococcus cyst absence of pain and a slow, steady growth of the tumor, so that a correct diagnosis can be made.

In general the diagnosis of cholelithiasis is easy if the distended gall-bladder is palpable, and there is history of a characteristic attack of pain. As soon as the attack passes over, it frequently happens that no distention of the gall-bladder can be made out even though it is full of calculi, some of which are lodged in the hepatic and common ducts. Tumor of the gall-bladder when present is so characteristic that exploratory puncture should never be made. The fluid in a diseased gall-bladder is usually infectious, and on account of the tension under which it accumulates it is apt to trickle from the opening made by a needle and set up peritonitis. The existence of a tumor of the gall-bladder without jaundice indicates closure of the cystic duct by a calculus, whereas jaundice together with a distended gall-bladder is often due to carcinoma of the pancreas, duodenum, or common duct. If there is no tumor of the gall-bladder and the attacks of colic are not characteristic, the diseases which must be excluded in making a diagnosis are lead colic, renal colic, intestinal colic and fecal obstruction, round ulcer, nervous hepatic colic, etc. Calculi are rarely found in the stools because they are often too large to pass through the cystic and common ducts. If a calculus does pass into the intestine, it may remain for weeks and finally fall to pieces; or, if very large, it may produce ileus. If the gall-bladder is contracted, or if the common duct is permanently obstructed by a calculus, examination of the abdomen may reveal nothing except a more or less tender area behind the right rectus muscle.

The functions of the stomach should be tested and the urine and feces examined in every case. If calculi larger than cherry-stones are found in the stools, it is fair to assume that they entered the intestine through a fistula. In chronic obstruction of the common duct examination of the urine shows the presence of biliary pigments in about two-thirds of the cases. Albumin is also frequently found.

It is difficult to show the existence of calculi by means of the *x*-ray. This has, however, been done in some cases. The diagnosis of acute obstruction of the common duct is so easily made as to require no further discussion. It is worth remarking that the calculus is usually

crowded into the common duct by the exudate occurring in the gall-bladder in an attack of acute serous cholecystitis. This exudate can many times be avoided by an early operation upon the gall-bladder. When the stone has entered the common duct, it is likely to remain and give rise to chronic obstruction.

Chronic obstruction of the common duct, or choledocholithiasis, often escapes diagnosis. Jaundice is often wanting; for when the common duct dilates, the infection subsides, and the bile flows by the calculus; also, if the cystic duct remains open and the bile flows through it and the perforated gall-bladder into the intestine there will be no jaundice. True attacks of colic may also be wanting. In their stead there may be simply unpleasant sensations at the pit of the stomach, or chills occurring every few days, and sometimes but not always accompanied by jaundice. It is very important to determine whether the obstruction in the common duct is due to a calculus or to pressure outside of the duct. In chronic obstruction due to calculus, the gall-bladder is usually contracted and cannot be felt. Jaundice is slight and transitory, the fecal discharge is sometimes brown and sometimes gray, and the attacks of fever are of varying degree and of an intermittent type. In chronic obstruction of the common duct due to tumor the gall-bladder is usually large and easily palpable as a tense swelling beneath the liver. Jaundice is marked and of constantly increasing intensity, while the fecal movements are constantly pale. Attacks of colic and fever are almost always wanting. This law, to which Courvoisier first called attention, holds good in about 75 per cent. of the cases.

This brief schedule of the symptoms shows that it is possible in many cases to recognize the particular form of cholelithiasis which exists. Much patience and practice are needed for exact diagnosis. A table of symptoms is submitted in order to aid practising physicians in distinguishing between the different forms of the disease. In using this table one should bear in mind that it does not absolutely apply to every case, and that the different forms of cholelithiasis so shade into one another that an exact diagnosis is sometimes impossible. The symptoms given in the table are those of typical cases.

Form of the disease.	Symptoms.	Diagnosis.	Treatment.
I. Calculi in the gall-bladder whose walls are slightly or not at all altered. The cystic duct is movable. The contents of the gall-bladder are clear bile which contains no purulent bacteria. There are no adhesions.	Usually no symptoms in the latent period. Occasionally slight epigastric pain due to temporary obstruction of the cystic duct. No passage of calculus. No enlargement of the liver.	Palpation shows nothing abnormal, or at most slight tenderness on pressure in the region of the gall-bladder (bimanual examination). Often mistaken for gastric ulcer, intestinal colic, movable kidney, or ventral hernia.	Medicinal treatment sufficient. Carlsbad cure to overcome the tendency to cholelithiasis.

Form of the disease.	Symptoms.	Diagnosis.	Treatment.
II. Acute cholecystitis in a relatively healthy gall-bladder. There is usually a large calculus in the neck of the gall-bladder. Contents of the gall-bladder cloudy or purulent. Walls thickened.	Tumor of the gall-bladder. Riedel's tongue-shaped lobe. Jaundice rare. Intense pain (stomach). Distention of the upper portion of the abdomen. Marked tenderness on pressure. General symptoms slight or severe according to the character of the infection (cholecystitis acutissima, with or without cholangitis); circumscribed peritonitis (pericholecystitis). Fever may or may not be present. No enlargement of the liver except with the cholangitis. Usually no discharge of calculus. If a calculus passes the cystic duct, there will be acute obstruction of the common duct (see IX.).	Diagnosis easy. May be confounded with appendicitis, especially if the appendix is directed upward. Examination should show that the tumor which is felt is a swollen gall-bladder. (Form, mobility, tension, etc.)	Operative treatment preferable, although by laxatives, etc., the inflammation may subside, the calculus remaining. Cystostomy is the normal treatment for cholecystitis.
III. Calculi in the gall-bladder in which there has been previous inflammation. Cystic duct open. Adhesions between the gall-bladder and intestine or omentum.	Similar to those of I. Usually intense colic due to kinking of the cystic duct and overdistention of the gall-bladder. Frequent vomiting. Intense pain on pressure. There may be entire absence of symptoms between attacks.	Similar to that of I. Tumor of the gall-bladder during attacks of colic if the gall-bladder is still capable of distention. Between the attacks palpation shows nothing abnormal.	When attacks recur frequently, operation is urgent, preferably cystectomy combined with drainage of the hepatic duct. The Carlsbad cure yields only temporary benefit.
IV. Acute cholecystitis in a gall-bladder much thickened from previous attacks of inflammation. Cystic duct obliterated or obstructed by calculi. Many adhesions. Contents of the gall-bladder scanty, mucous, or purulent. Fistula between the gall-bladder and intestine.	No palpable tumor because the gall-bladder is well up under the liver. Tenderness as in II. Symptoms variable. Jaundice usually wanting, but if present it usually indicates the passage of a calculus into the common duct (see IX.).	Diagnosis difficult because the results of palpation are unsatisfactory. Diagnosis must often be made from the history. If the general infection is marked and there is no tumor, purulent cholecystitis with moderate pain has been mistaken for typhoid, malaria, or septicæmia. The forms of cholelithiasis III. and IV. are illustrations of chronic recurrent cholecystitis.	Cystectomy should be performed if the Carlsbad cure is unsuccessful, as it is in 50 per cent. of the cases. Complete operation performed when possible.

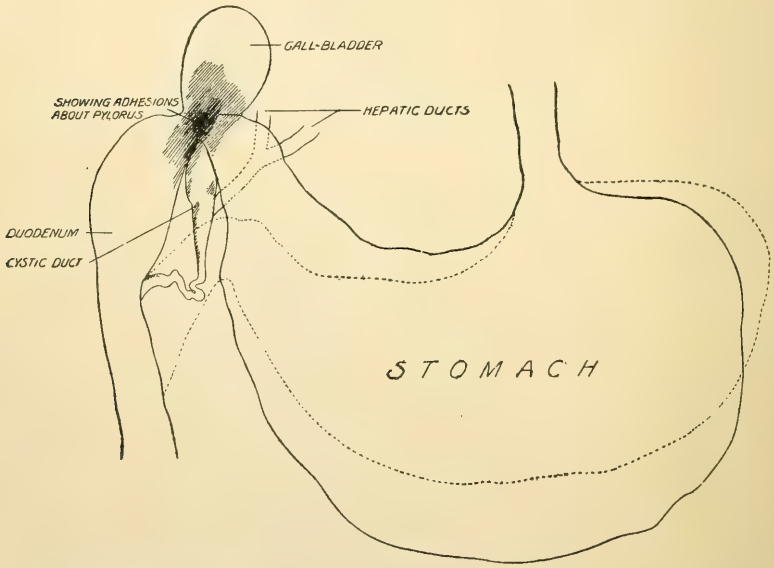
Form of the disease.	Symptoms.	Diagnosis.	Treatment.
V. Conditions the same as III., except that calculi are wanting and adhesions are present.	Pain frequently produced by changes in position (standing up). Otherwise symptoms as in III. Adhesions may cause pyloric stenosis, dilatation of the stomach, or ileus.	Similar to that of III. The symptoms are protracted. The stomach becomes dilated.	Similar to that of III. Cystectomy is the operation of choice, combined with gastro-enterostomy for peripyloritis, since pyloroplasty is uncertain.
VI. Hydrops of the gall-bladder. Cystic duct obliterated or obstructed by a calculus. The gall-bladder contains a usually clear fluid. Its walls are thin as paper.	There may be no symptoms. Or the patient may notice a tumor. But there is often epigastric pain. No passage of the calculus, no jaundice, no swelling of the liver. Riedel's tongue-shaped lobe sometimes present. Sterile contents of the gall-bladder may at any time become infected (through the blood).	Diagnosis easy. The gall-bladder may be mistaken for a movable kidney. The tumor if not adherent moves most from side to side. It can be pushed downward, but comes back at once. Tenderness on pressure is slight. If the gall-bladder is contracted, hydrops fails to produce a palpable tumor. Diagnosis under such circumstance is difficult, as in IV.	Cystostomy with cysticotomy, or, better still, cystectomy.
VII. Empyema of the gall-bladder. The gall-bladder contains pus. There is a calculus in the cystic duct and adhesions are present.	Symptoms at first as in II.; later fever may disappear and the symptoms become as in VI., although the tumor is usually smaller. No passage of calculus. Pain is usually confined to the region of the gall-bladder and the pit of the stomach, but it may extend to the back, breast, etc.	Do not aspirate for the sake of diagnosis. Similar to VI. If perforation occurs, there will be symptoms of peritonitis. At first the gall-bladder is very painful in empyema; later the tenderness lessens or disappears. There is often an encapsulated abscess in the neighborhood of the gall-bladder.	Similar to that of VI.
VIII. Carcinoma of the gall-bladder which contains a calculus.	The first symptoms are those of indigestion without jaundice. If the common duct and the portal lymphatic glands become affected, jaundice and ascites develop. The tumor is hard and uneven. Colic is often wanting. Later cachexia develops.	Tenderness slight. Diagnosis difficult before jaundice appears. It is easy if the portal glands become affected and ascites develops. The carcinomatous gall-bladder which contains calculi often becomes inflamed (empyema).	Treatment unsuccessful except in an early stage, then cystectomy with extensive resection of the liver. In empyema of a carcinomatous gall-bladder cystostomy is of slight benefit.

Form of the disease.	Symptoms.	Diagnosis.	Treatment.
IX. Acute obstruction of the common duct by a calculus.	Jaundice is well marked, and there are colic and vomiting and frequently chills and fever. The symptoms subside if the calculus passes into the duodenum or becomes loosened. In the former case the calculus may be found a few days or a few weeks later in the feces, but not necessarily.	Diagnosis easy. Typical attacks of colic. Pain extends to the breast and back, while pain due to calculi in the gall-bladder (cholecystitis) is usually confined to the region of the gall-bladder and stomach.	Internal medication. Morphine subcutaneously. Hot poultices. Operation only exceptionally necessary (drainage of the hepatic duct).
X. Chronic obstruction of the common duct by a calculus situated in the supraduodenal portion.	Jaundice moderate or absent. It changes from day to day; stools sometimes brown, sometimes gray. There is often intermittent fever. There is usually pain. The patient gradually becomes cachectic and takes on a hemorrhagic diathesis.	Gall-bladder contracted and not palpable. Liver more or less enlarged. Tenderness on pressure over its centre. The spleen often enlarged.	Choledochotomy and inspection of the relations of the gall-bladder. Cystectomy and drainage of the common duct if necessary.
XI. Chronic obstruction of the common duct by a calculus situated in the duodenal papilla.	Symptoms as in X. Jaundice usually intense and constant, although it may disappear with subsidence of the inflammation.	Similar to that of X. Gall-bladder contracted if previous inflammations have affected its walls so that they cannot dilate, otherwise a tumor may be present (empyema coexisting).	There is possibility of a fistula between the common duct and duodenum. If no improvement after three months at Carlsbad, an operation should be performed. Choledochoduodenostomy.
XII. Chronic obstruction of the common duct by a tumor of the pancreas (carcinoma, interstitial pancreatitis), duodenum, or common duct itself.	Marked jaundice, usually constant and gradually increasing. Stools always gray. Usually no fever. Slight or no pain. If present, it is of a dull and not of a colicky character.	Gall-bladder usually large. Liver enlarged. Tenderness on pressure slight or wholly wanting. Spleen often enlarged.	Expectant treatment. Possibly cholecystenterostomy (risk of cholangitis). Treatment of little service in carcinoma, but successful in chronic pancreatitis.

Prognosis.—In most cases of cholelithiasis the prognosis is uncertain even when the attacks of colic are mild and infrequently repeated. In many cases the disease progresses without marked symptoms and then suddenly becomes much worse. On the other hand, encapsulation of the calculus, dying out of the infection, or perforation, may lead to a happy termination of a very severe case. It is quite impossible to prophesy the outcome. The disease may continue for years. The chief dangers of cholelithiasis are due to perforation, cholangitis, and carcinoma. But even if none of these complications arise, it may wear the patient out with its ever-recurring pain. It shows little tendency to spontaneous cure, though it is frequently marked by latent

periods. Temporary benefit is frequently obtained by rest-cures, by cures at Carlsbad or elsewhere, and by proper treatment of the accompanying gastric or intestinal catarrh (irrigation, oil injections). The spontaneous passage of a calculus through the intestine may bring about a cure, but other calculi usually remain in the gall-bladder, any one of which may set up another inflammatory attack. Spontaneous cure may also follow the passage of a calculus by perforation from the gall-bladder to the colon, or from the cystic duct into the duodenum, or from the papilla into the duodenum. Such results are to be looked upon as happy accidents which cannot at all be counted upon in attempting the prognosis of the disease. Furthermore they frequently lead to the development of cholangitis ; or the inflammation may produce peritoneal adhesions with resultant digestive disturbances. (Figs. 319 and 320.)

FIG. 319.

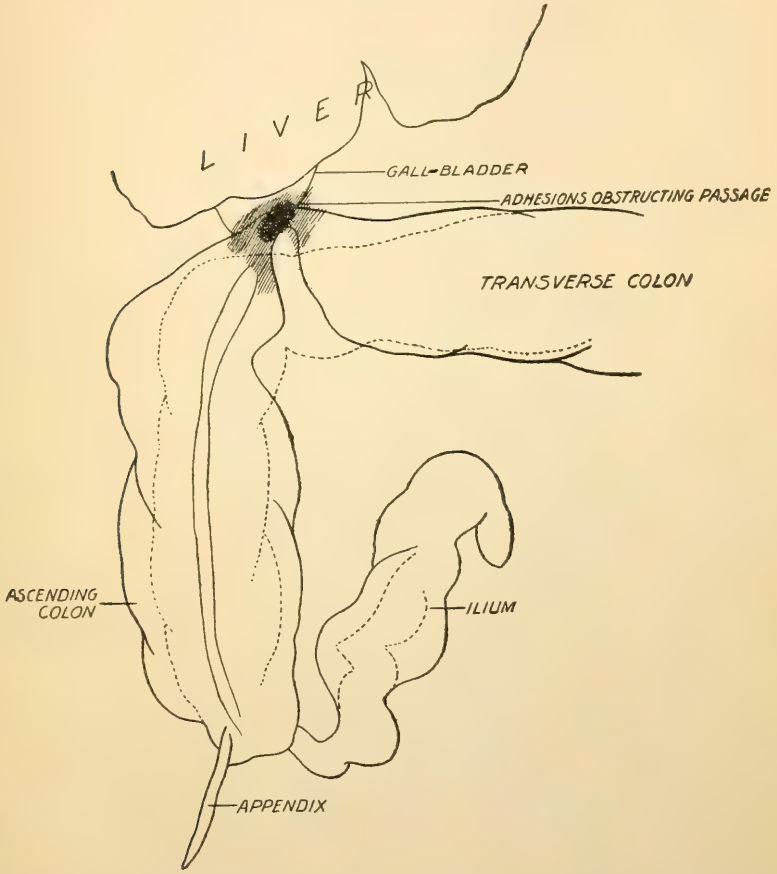


Showing the effects of adhesions between the liver, gall-bladder, and pylorus. The pylorus is drawn out of place and stenosed, and the stomach is dilated to about four times its normal capacity. (Niles.)

Indications for Operation.—Unfortunately, surgeons and physicians are not yet agreed as to the indications in cholelithiasis which make operative treatment necessary. Some, like Winiwarter, believe that operation is indicated as soon as the diagnosis of calculi is made. Others, like Riedel, believe that internal treatment has its place, but that it should not be continued too long, and that it is better to operate while the calculus is still easily accessible in the gall-bladder. There is still a third opinion to the effect that operation is not indicated until internal treatment has been tried for a long time and has failed, and there are others who do not advocate operation at all except under conditions which threaten the patient's life.

It should be clearly understood that internal treatment, such as that given at Carlsbad, rarely cures a patient, but produces a latent period in the disease in about 50 per cent. of the cases. However, such a latent period is looked upon by these sufferers as a cure, and they are not likely to agree to operation until the pains recur. The patient should be more or less under observation while he is receiving medical treatment. Thus, an acute seropurulent cholecystitis with

FIG. 320.



Showing adhesions between the gall-bladder and colon, almost completely obstructing the latter. (Niles.)

marked distention of the gall-bladder may disappear during internal treatment, but it may also lead to perforation. In these cases operation—that is, cystostomy—has so slight a risk that it ought to be given a preference over internal treatment. If there is a calculus in the common duct, the patient may be advised to begin treatment at Carlsbad, but on account of the risk of cholæmia and infection opera-

tion should not be postponed too long. Other patients seek surgical relief on account of the pain, or the gradual loss of weight, or jaundice, or fever.

Operation is indicated:

1. In all cases in which the internal treatment is unsuccessful, as well as in cases which do not admit of any delay (acute suppurative cholecystitis with chronic obstruction of the cystic duct).

2. In all cases in which treatment by medicine, diet, and baths fails to prevent recurrences of the trouble, and in which the attacks are sufficient to interfere seriously with the patient's mode of life. This is the position taken by most physicians. Frequently a patient who suffers from calculi will have contracted the morphine-habit, from which he can best be cured by an operation to relieve him of his trouble. If the gall-bladder is plainly distended, or there is enlargement of the liver, or jaundice, it is easier for the patient as well as for the physician to decide upon operation. But the absence of these physical signs must not be considered to throw doubt upon the diagnosis. The history of the disease is often of more value in making a diagnosis than the results of physical examination. This is especially true if there are repeated attacks of pain. Such pains are frequently due to adhesions between the gall-bladder and portions of the intestine, the results of circumscribed peritonitis, and these adhesions are usually not palpable. Hence repeated attacks of pain may be looked upon as an indication for operation in the absence of any positive results of palpation.

3. In all cases in which there is a suspicion of carcinoma (a hard tumor of the gall-bladder), or of perforation, or of suppuration in the vicinity of the biliary passages. Unfortunately, diagnosis in all these cases is apt to be made after the favorable time for operation has passed.

The idea of early operation in cholelithiasis is undoubtedly gaining ground both among surgeons and physicians. When one considers the distressing pathological conditions which can be produced by calculi, and when one compares the ease of cholecystostomy with the great difficulty often experienced in removing a calculus from the common duct, the advice of Riedel is appreciated. He advocates removing a biliary calculus early, before it has time to leave the gall-bladder. On the other hand, one must not forget that even a very severe attack may pass over. If the pains come on at rare intervals and the patient feels perfectly well between attacks, the indication for operation is less urgent. Then the social condition of the patient also has its bearing. While a rich man can spare himself, can indulge in cures at Carlsbad or elsewhere, a man who depends upon his health to earn his living will rather incline to operation.

Operation upon men is more difficult than upon women since the former press and strain more during the narcosis and the fixedness of the abdominal organs makes it more difficult to expose the diseased parts. Their power of resistance is often reduced by alcohol and

nicotine. Hence a cystostomy may be justifiable in men in circumstances in which a cystectomy would be performed in women. Old age is no counterindication for operation. Kehr has successfully operated upon many patients over sixty years of age. In the aged the prognosis should be guarded since carcinoma frequently coexists. If one is skilled in the technic, his results will be notably better than those of a beginner, since the time occupied in the operation will be decidedly less (half an hour for choledochotomy, as compared with two or three hours).

Operation is counterindicated:

1. In acute obstruction of the common duct. Under such circumstances there is a fair chance that the calculus will pass through the common duct into the duodenum, and that any other calculi remaining in the gall-bladder will give no further trouble. If fever is added to the symptoms of obstruction of the common duct, showing that cholangitis is taking place, and the patient's general condition is worse, operation with drainage of the hepatic duct should be performed.

2. In very old individuals, and in those who suffer from diabetes, arteriosclerosis, cardiac or pulmonary disease, and in very stout persons.

3. In extensive carcinoma of the biliary passages.

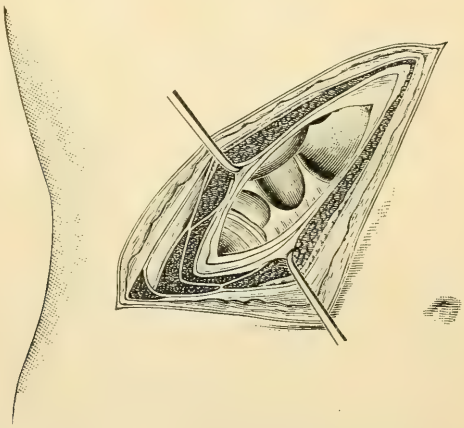
4. In cases of repeated attacks of icterus and the discharge of small calculi, provided the patient feels well between the attacks. There is always a possibility that such a patient may be cured by internal treatment.

While it is rarely possible to carry out Riedel's idea of removing biliary calculi before they leave the gall-bladder, yet an improvement in the diagnosis of cholelithiasis will bring one nearer and nearer to this desired position. No one except a thoroughly skilled surgeon should attempt to operate for cholelithiasis. What is apparently a very simple case may turn out to be a very difficult one. The surgeon may begin with the expectation of performing cystostomy, and find it necessary to drain the hepatic duct or to perform gastro-enterostomy on account of pyloric stenosis. For the same reason it is best to perform operations of this sort only in a well-appointed hospital.

Technic of Operation.—The patient should be prepared with baths, cathartics, etc., as for a laparotomy. Asepsis should be carefully observed. The incision may be a transverse one parallel to the costal margin or lower margin of the liver (Courvoisier, Robson (Figs. 322 and 323)), or along the outer margin of the right rectus muscle (Tait), or in the muscle itself (Riedel). Czerny makes a vertical incision in the linea alba and a right transverse incision which joins this below the umbilicus. Lövker employs a median incision. Kocher prefers an oblique incision. (Fig. 321.) Kehr makes use of an incision similar to the one advocated by Bevan. It begins at the ensiform cartilage, extends 3 or 4 cm. (1.2 to 1.6 inches) downward in the median line and then bends to the right parallel to the costal margin until it has divided two-thirds of the rectus muscle, when it bends downward and follows the muscular fibres. This incision, the "wave cut," as he

calls it, is a combination of vertical and transverse lines, which gives an excellent view of the biliary tract, especially if a firm cushion or sand-bag is placed under the patient's back. It is rarely necessary to resect the costal cartilages, as advocated by Lannelongue, or to resect the overlying portion of the liver. Superficial bloodvessels are clamped, but not ligated unless the patient has jaundice. The peritoneum is lifted with two sharp forceps and divided between them. The incision is prolonged and a large gauze compress is introduced into the abdominal cavity. If the gall-bladder is adherent to the abdominal wall or an abscess exists between these two structures, the relations of the parts may be better known after aspiration with a fine needle. If there are no adhesions, the biliary passages can be mapped out by inspection, and still more accurately by palpation, since the finger recognizes, as the eye cannot, every adhesion which may exist

FIG. 321.



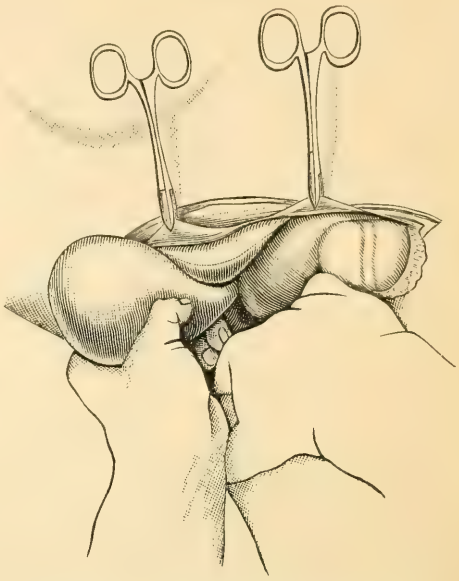
Exposure of the stomach, gall-bladder, and colon by the oblique incision. (Kocher.)

between the biliary passages and the intestine. (Figs. 319 and 320.) Any recent adhesions about the gall-bladder are torn through with the finger, while old adhesions should be divided under guidance of the eye. It is rarely necessary to ligate them. Any adhesions between the cystic duct and the stomach or duodenum, and between the gall-bladder and colon, may contain a fistula between these organs. If such be the case, the abdomen should be protected from the escape of bile or feces, the opening in the stomach or intestine carefully sutured, and the gall-bladder removed. In every case the surgeon should make it a point to expose freely, inspect, and palpate the larger bile-ducts. This should only be omitted in case the patient is weak or takes the anæsthetic badly. Such a thorough examination is possible in about 98 per cent. of the cases. The pylorus, duodenum, and pancreas should also be examined since these organs are often affected after cholelithiasis. The glands along the cystic or common duct are frequently so hard that they have been mistaken for calculi and cut into.

The technic of special operations is as follows:

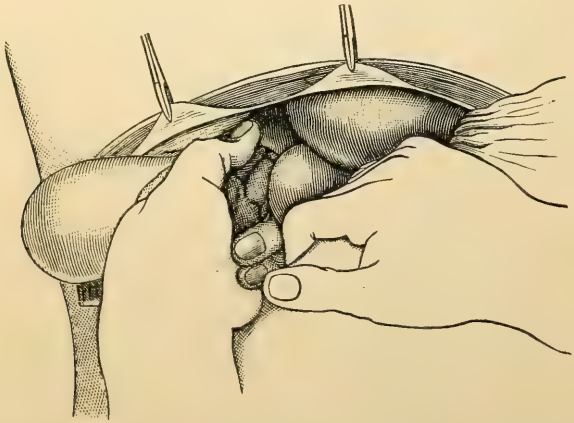
1. Cystostomy in two steps: The short vertical incision (5 to 10 cm.—2 to 4 inches) is made in the outer third of the right rectus muscle or along its outer border. The fundus of the gall-bladder is wrapped in sterile gauze and brought out through the incision in the peritoneum. The rest of the wound may be closed, but sufficient space should remain to permit the completion of the operation, namely, the opening of the gall-bladder at a later date. The gall-bladder may be fixed in position by a few sutures, or the point in it at which the incision is to be made may be marked by a black silk thread. The adhesions formed after suture are firmer than those which form if only a tampon is used. Care should be taken not to puncture the gall-bladder with a needle. Its wall is often very thin. The dressing is first changed ten to fourteen days later, and if the adhesions are then firm, the gall-bladder is opened with a sharp pointed knife or a fine thermocautery. Any calculi which it contains are extracted with forceps or a curette.

FIG. 322.



Robson's incision for exposing the gall-bladder and common duct. A sand-bag is placed under the loin.

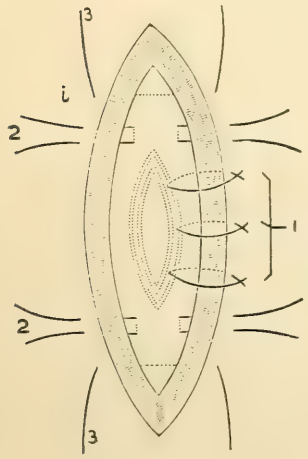
FIG. 323.



Robson's incision for exposing the gall-bladder and common duct. A sand-bag is placed under the loin.

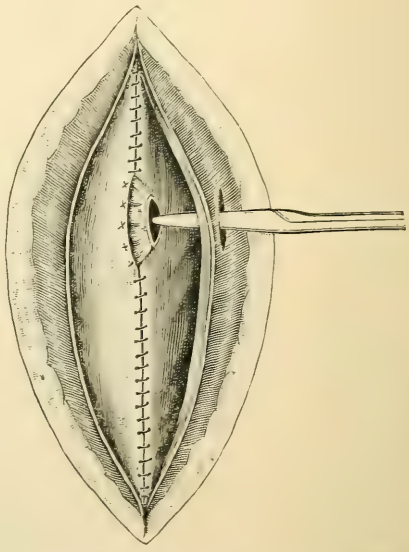
2. In completing a cystostomy in one operation it is important to see that the contents of the gall-bladder do not escape into the peritoneal cavity, for they are generally infectious. For this purpose compresses wrung out in salt solution are placed on all sides of the gall-bladder, and its contents are aspirated by a good syringe. Infection can thus be avoided. If the gall-bladder is very large, it can be more easily drawn forward, and if the liver is also movable, aspiration will be unnecessary. The gall-bladder can be brought out through the abdominal wound, opened with a scalpel, and its contents caught in a basin. If aspiration is employed, it is followed by an incision. A silk thread is passed through each side of the wound in the gall-bladder for the purpose of tension. Sometimes the contents of the gall-bladder are so thick and tough that they cannot be aspirated.

FIG. 324.



Cholecystostomy. Fixation first and then incision. 1, serocutaneous suture to keep the gall-bladder open; 2, lateral fixation; 3, angular fixation. (Terrier.)

FIG. 325.

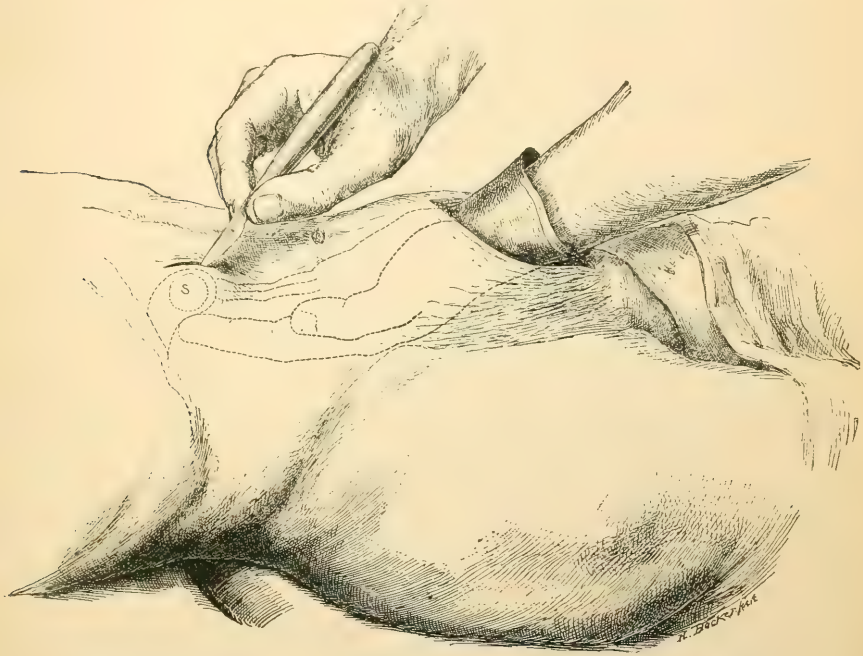


Cholecystostomy. Incision first and then fixation. Peritoneum sutured. (Pantaloni.)

An incision is then made and the thick, stringy bile sponged out. One should be careful not to soil the fingers with this infectious material. Irrigation is for the same reason inadvisable. The cavity of the gall-bladder is wiped dry with strips of gauze and the cystic duct is palpated from the peritoneal cavity. If it contains a calculus, this should be removed at once, since its later removal is far more difficult. On this account it is better not to suture the gall-bladder in the wound before opening it, as is recommended by Terrier. (Fig. 324.) Manipulation of the calculus from within the peritoneal cavity will aid in its extraction. If this fails and the gall-bladder is to be preserved, the cystic duct must be opened and the calculus removed. (See paragraph 3.) In certain cases, either on account of local or

general conditions of the patient, this exposure of the ducts is impracticable, and the surgeon must content himself with simple cystostomy. The opened gall-bladder is then to be sutured to the parietal peritoneum and deep fascia (Fig. 325), never to more superficial tissues, and a fair-sized soft rubber tube should be left in it. Prolapse of the mucous membrane of the gall-bladder may produce a permanent fistula. If the incision is sufficiently large to render this likely, it may be partially closed by sutures. The position of the gall-bladder in the abdominal wound should be such that there is no tension on the sutures. Kehr prefers silk to catgut, leaving the ends of the sutures long so that they can be removed in ten days. If they

FIG. 326.



Method of incising the gall-bladder for calculus during a laparotomy. (Kelly.)

find their way into the gall-bladder, they may lead to the formation of new calculi. It is often difficult in cutting out these sutures to be sure that no portion of the silk remains. A good way to avoid this is to tie a long piece of silver wire in each suture. Tension upon this wire will make it easy to cut the suture itself, and not merely to cut off its ends. The portion of the abdominal wound not occupied by the gall-bladder is closed by silk sutures which pass through all its layers. A large aseptic dressing is applied, through which the rubber tube passes and enters a bottle containing a 3 per cent. solution of carbolic acid.

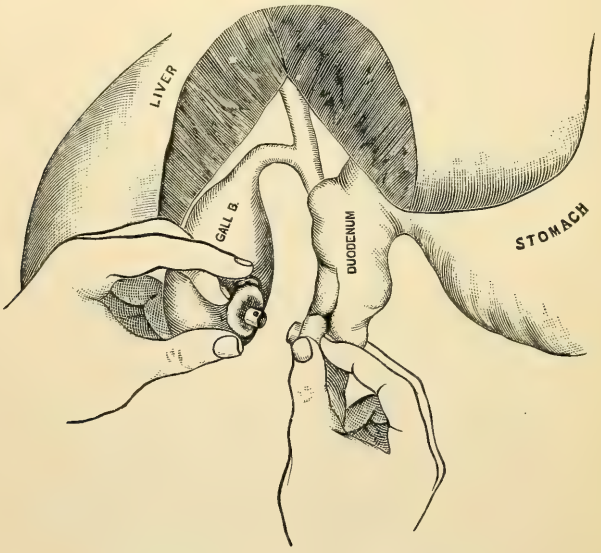
Kelly has suggested a quick method of incising the gall-bladder

for a calculus recognized during a laparotomy for some other purpose. (Fig. 326.)

3. Cysticotomy, or incision of the cystic duct, presupposes a free exposure of the duct. The incision should be made directly down upon the calculus. In the extraction of the latter, injury of the walls of the duct should be avoided. Rather than risk this the incision should be prolonged. The incision is closed by a suture which passes through the serous and muscular layers only, as incrustation may take place upon any thread which reaches the lumen of the duct. Cysticotomy should invariably be followed by cystostomy, and gauze tamponade at the same time will still further insure the safety of the patient.

4. Cholecystectomy, or removal of the gall-bladder, was first performed by Langenbuch in 1882. The abdomen is opened by the

FIG. 327.



Cholecystenterostomy with Murphy button.

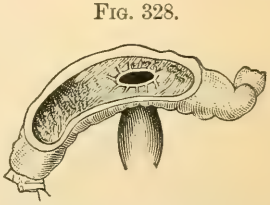
wave incision above described, and any adhesions between the gall-bladder and intestine or omentum are divided. The removal may be begun at the fundus or at the cystic duct, according to circumstances; usually the latter method is preferable. The cystic duct is seized with a curved clamp so that no fluid may escape from the gall-bladder. The cystic duct is then surrounded by an abdominal pad to prevent the unnecessary escape of bile from the common duct, and divided. The fundus of the gall-bladder is seized with a strong clamp, and the serous coat of the liver is divided with a U-shaped incision and the gall-bladder pulled from its bed. This extirpation is not difficult in most cases. If the tissue of the liver is torn, it should be sutured.

Both branches of the cystic artery require careful ligation, if post-operative hemorrhage is to be avoided. It is unwise to include the arteries and the cystic duct in a single ligature. They should be tied separately. The gall-bladder may be removed before it is opened; or if the difficulties of such a procedure are great, or fistulas exist, it is better to open the bladder, wipe it dry, stuff it with gauze, and separate it from the liver. In any case it is better not to close the abdominal wound completely, but rather to tampon the stump of the cystic duct or wound in the liver, for one can never be certain that there will be no hemorrhage or that the ligatures of the stump of the cystic duct will not give way.

A portion of the gall-bladder may be resected; for example, its under surface. The cystic duct should then be ligated and the remnant of the gall-bladder which remains should be thoroughly cauterized with the Paquelin cautery. Kottmann leaves a portion of the neck of the gall-bladder, a procedure which has little to recommend it. Mayo removes the mucous membrane of the gall-bladder as far as that of the cystic duct, leaving the other coats of the organ in position.

5. Cystendysis, or the so-called ideal operation of Courvoisier, consists in opening and emptying the gall-bladder, closing it by a serous and muscular suture and a second serous suture, and then closing the abdominal cavity. None of the stitches used should enter the lumen of the gall-bladder lest incrustation follow. This operation is not suited to any case of cholelithiasis.

FIG. 328.



Gall-bladder and duodenum fifteen months after cholecystenterostomy. (Kappeler.)

The risk of the "ideal" method consists in the possible rupture of the suture and the escape of bile into the peritoneal cavity. Its object is, of course, to avoid a permanent fistula which may follow drainage of the gall-bladder. Czerny modifies the operation by stitching the sutured gall-bladder into the abdominal wound, so that if it ruptures the bile will escape outward rather than into the peritoneal cavity. According to Kehr's views, the principle of this operation is wrong. The drainage of the gall-bladder is in no sense dangerous, nor does it annoy the patient if the dressing is properly arranged. Moreover, when the flow continues for a long time the common duct is usually obstructed, and drainage under such circumstances is necessary. If a purely mucous discharge continues, the cystic duct is obstructed, and here again cystostomy is preferable to Czerny's operation of cystendysis. Most gall-bladders which are operated upon are inflamed and free drainage is beneficial. It is easy for a surgeon to overlook a small calculus in the cystic duct, especially if the mucous membrane is swollen. If the gall-bladder is sutured and the suture holds, the calculus will be driven into the common duct by the gradually increasing secretion in the gall-bladder, obstruction of the common duct will result, and the condition of the patient will be considerably worse than before.

Experience teaches that cystendysis and its modifications had better not be performed.

6. Anastomosis between the gall-bladder and intestine was first carried out by Winiwarter in several stages. More recently it has been performed as a single operation by Kappeler. The duodenum is the most favorable portion of the intestine for this purpose, so that the patient may receive the benefit of the bile as high up in the intestinal tract as possible. (Figs. 327 and 328.) If adhesions prevent such an anastomosis, a loop of jejunum should be chosen; only in extreme cases should an anastomosis be made between the gall-bladder and the colon. An anastomosis between the gall-bladder and the stomach has several times been successfully made without any resulting disturbance of digestion.

This operation is similar to gastro-enterostomy. The contents of the gall-bladder are in part aspirated, and its fundus is divided transversely for a distance of 2 cm. (0.8 inch). The intestine is next opened opposite to its mesentery for an equal distance. The posterior seromuscular suture is inserted, and the usual suture of the mucous membrane is omitted on account of the risk of incrustation. The seromuscular suture is continued anteriorly, and a few interrupted Lembert sutures are added wherever the anastomosis seems weak. This suture possesses many advantages over a Murphy button. An anastomosis between the intestine and gall-bladder renders it possible for feces or intestinal bacteria to enter the biliary passages and set up suppurative cholangitis. For this reason one should carefully consider the advantages and disadvantages before performing this operation. Successful anastomoses have been made between the cystic or common duct and the stomach or duodenum, but the technic of these operations is difficult.

7. If there is a suppurative process in the neighborhood of the gall-bladder, thorough drainage is more important than the simple speedy removal of the calculus. If the latter object can be accomplished without infection of the peritoneal cavity, the operation may be completed at once; otherwise it is better to overcome first the suppuration and to remove the calculus after the wound has become clean. If the gall-bladder perforates into the peritoneal cavity, an immediate laparotomy is indicated. The gall-bladder may be removed, or a fistula established, according to circumstances and the condition of the patient. If the perforation is in the cystic duct or hepatic duct, or common duct, one should content himself with gauze drainage, and this treatment is satisfactory in many cases of perforation of the gall-bladder.

8. The most difficult operation which one has to perform upon the biliary tract is choledochotomy, or incision of the common duct, for the purpose of removing a calculus. After opening the abdomen the surgeon first investigates the condition of the gall-bladder. This organ is usually contracted in cases of obstruction by a calculus in the common duct (Courvoisier's law). Still, if empyema exists, the gall-

bladder may be dilated. Tumors between the liver and the gall-bladder on one side, and the omentum, stomach, intestine, and parietal peritoneum on the other, must be separated before the common duct can be reached. In separating adhesions one should keep a sharp watch for fistulas between the gall-bladder and intestine. If the surgeon feels the calculus in the common duct, he can usually approach it more satisfactorily in the supraduodenal portion. He fixes the calculus with the thumb and forefinger of the left hand, places abdominal pads about it, and incises the wall of the duct directly down upon the calculus. Bloodvessels may be pushed aside or ligated and divided. The moment the common duct is incised bile will flow from it freely. It should be sponged away as it escapes. The calculus may be pressed out with the thumb and finger or extracted with forceps. The wound in the common duct is held open with large thumb-forceps and a probe passed upward into the hepatic duct and downward toward the duodenum in order to reveal the presence of other calculi. If such are found, they should be extracted through the incision already made, if possible. Special curved instruments have been devised for this purpose. If a calculus is wedged in the duodenal end of the duct, the forefinger of the left hand should be passed into the common duct while the fingers of the right hand are pressed against it from within or from the outside of the peritoneal cavity. This bimanual manipulation will often loosen the calculus and bring it out of the incision in the common duct. If a calculus in the hepatic duct cannot be extracted with instruments through the incision already made, it must be cut down upon and removed. If a calculus is wedged in the papilla, the anterior wall of the duodenum may be transversely incised and the papilla dilated or incised (McBurney's operation); or the posterior wall of the duodenum, and through it the common duct, may be incised in order to extract the calculus (Kocher's internal choledochoduodenostomy). The openings in the common duct and posterior wall of the duodenum are sutured so as to form a fistula. The incision through the anterior wall of the duodenum is closed by a suture. Körte and others have removed calculi impacted in the papilla by incisions through the head of the pancreas.

It is very difficult to expose the common duct if the liver is rigid and the ribs are inelastic. The portion above the duodenum is most easily reached and incised, while the portion behind and below the duodenum can be reached after the duodenum has been separated from it, or after division of the lesser or greater omentum. These operations are very difficult, and no one should attempt them who is not thoroughly familiar with the anatomy of the region. If it is absolutely impossible to follow the gall-bladder and cystic duct to the common duct, the surgeon may reach the common duct by following along the pylorus and duodenum.

In performing choledochotomy the condition of the gall-bladder should always be noted. It may be shrunken to the size of a pea, in which case it can be left untouched. If it contains either calculi or

pus, it should be sutured in the abdominal wound and drained when this is possible; or, a rubber tube may be inserted into it and the wound in the gall-bladder so stitched about the tube that the joint is water-tight. The tube is further surrounded by strips of gauze which are brought out through the abdominal wound. In this manner all the bile will drain through the tube and a fistula will be established, so that risk of peritoneal infection will be avoided. A better plan is to remove the gall-bladder. The incision in the common duct may be sutured if inflammation does not prevent. If there is a cholangitis, it is better to drain the hepatic duct. The best way to do this is as follows: The gall-bladder is removed, and the common duct is opened from the point where the cystic duct is cut across. Any calculi are removed and a long soft rubber tube of suitable calibre is passed into the hepatic duct, surrounded with gauze strips, and brought out through the abdominal wound.

Kehr has treated about 90 patients by drainage of the hepatic duct, with complete success. Indeed, he rarely sutures an incision into the common duct, preferring to follow it by hepatic drainage. Such an operation requires less time than suture and its mortality is less (about 3 to 5 per cent.). This drainage also renders incision in the common duct accessible so that calculi may subsequently be removed with forceps. This is an important point, because even the most experienced surgeon overlooks calculi in from 10 to 15 per cent. of these cases. In some of these cases, doubtless, the calculi are situated in the higher biliary passages and do not enter the hepatic duct until after the operation. If the incision in the common duct is sutured, the region of the wound should be thoroughly tamponed with sterile gauze. While drainage of the hepatic duct is most easily carried out after removal of the gall-bladder, it can also be carried out in combination with cystostomy or without cystostomy when an empty gall-bladder is left in place.

9. Anastomoses between the cystic duct and the common duct on the one hand, and the stomach or intestine on the other, have been referred to in paragraph 6. The crushing of a calculus in the gall-bladder or cystic or common duct should be avoided if possible, as there is no guarantee that such operation will not be followed by the complications of cholelithiasis, such as abscess of the liver or subphrenic abscess. Pyloric and duodenal stenosis are described elsewhere.

In passing a probe from the gall-bladder through the cystic duct it is necessary to proceed carefully lest the probe catch in a fold and lead to perforation. Such probing is rarely successful. The proposition to cleanse the common duct by passing instruments through the gall-bladder rests on false ideas and is not to be recommended.

Anastomoses between the hepatic duct or one of its branches and the intestine are operations too rarely performed to merit a description in this place.

Choice of Operation.—A calculus in a movable gall-bladder demands a very different operation than does a calculus in the deep common

duct. A contracted gall-bladder is not suited to an ordinary cystostomy in one stage since it cannot be brought into the abdominal wound and fastened to the parietal peritoneum. If the gall-bladder is lacerated or otherwise seriously affected, it should be removed. If a calculus is embedded in the cystic duct and cannot be loosened, the duct should be incised to permit its extraction, or cystectomy should be performed. Operation in two stages oftentimes reduces the risk to the life of the patient, but is sometimes followed by a biliary or mucous fistula.

These examples suffice to show that no single method of operating is applicable to all conditions. This is especially true in the presence of inflammation. Drainage is the general principle of gall-stone surgery, since inflammation is present in the majority of cases. For this reason so-called "ideal" methods in which incisions are sutured without drainage should have no place in the treatment of cholelithiasis. These methods will succeed in certain cases, but they are unsafe, and one never knows whether all the calculi have been removed or not. Even if pure bile flows through the cystic duct during the operation upon the gall-bladder, there may still be calculi situated in diverticula which at a later period can become loosened and give trouble. The attempt to avoid the risk of suture of the gall-bladder and at the same time to avoid the presence of a biliary fistula by stitching the sutured gall-bladder in the peritoneal incision is a step backward in biliary surgery. Calculi in the gall-bladder should be treated by cystostomy in one or two stages or by cystectomy.

If the wall of the gall-bladder is healthy and the organ can be readily stitched into the abdominal wound, cystostomy should be performed in one stage. The only advantage of an operation in two stages is the avoidance of infection, and in the circumstances indicated this can be avoided by an operation complete in one stage. Its disadvantages are the difficulty in removing deep-seated calculi, subjecting the patient to a second operation, etc. If the gall-bladder is contracted and deeply situated, the operator must choose between cystostomy in two stages, the use of a rubber tube, and cystectomy. In such circumstances Kehr removes the gall-bladder, if this can be easily done, as in its shrunken condition it is of no possible use to the patient. His next choice is for the use of the rubber tube, although infection of the peritoneal cavity may occur by this method. Operation in two stages may become necessary on account of the unfavorable condition of the patient, but he has employed it only once in 200 operations of this character.

If the gall-bladder is adherent to the abdominal wall, it may be opened without opening the peritoneal cavity. Deeply placed calculi may be known by the continuance of a mucous fistula. They can perhaps be extracted by forceps or a spoon. If not, a second laparotomy in the median line will be necessary.

If the gall-bladder is ulcerated or otherwise degenerated, or the cystic duct obliterated, cystectomy should be performed. If the gall-

bladder is so adherent that its removal entails risk, it may be split throughout its lower length and the mucous membrane removed or destroyed with the Paquelin cautery. Chronic closure of the cystic duct by a calculus is a further indication for the removal of a gall-bladder. In such circumstances the patient has long before accustomed himself to do without his gall-bladder. If severe inflammatory conditions, such as acute seropurulent cholecystitis, forbid removal of the gall-bladder, a calculus in the cystic duct may be cut down upon and extracted. As the surgeon becomes more experienced he will prefer cystectomy to cysticotomy.

Thus it is seen that different conditions demand different methods of operating, and that operation should be chosen which most nearly meets the requirements of any particular case. In many cases the beginner should content himself with cystostomy. Mucous or biliary fistulas which may result can be overcome by choledochotomy, cysticotomy, or cystectomy, but these operations performed secondarily are often very difficult. If the liver is movable and the abdominal walls are relaxed, primary cystectomy is often simpler than cystostomy. In men with firm abdominal walls the reverse is usually true. In acute inflammatory and suppurative cases cystostomy is usually indicated. The removal of an infectious exudate is then the chief object of treatment, the removal of the calculus being secondary. In chronic cholelithiasis when operation is performed in the interval cystectomy is the operation of choice. (Compare Operations upon the Appendix Vermiformis.)

A gall-bladder which does not contain calculi, but is adherent to the stomach, intestine, or omentum, should be excised. Separation of the adhesions will in some cases relieve the patient of his symptoms, but extirpation of the gall-bladder itself is a more certain cure. Chronic obstruction of the common duct by a calculus is best treated by choledochotomy and hepatic drainage. One ought never to crush a calculus in the common duct. If such crushing occurs accidentally, one may perhaps trust to it as a cure, but it is well to remember that the fragments often give rise to further calculi. Clearing out of the common duct through the gall-bladder, as recommended by Rose and Kuhn, is an operation which should seldom be performed because it is not likely to result in a perfect cure. Frequently calculi are situated in the hepatic duct so that they cannot be reached at all through the gall-bladder; and any way, the injury caused by attempts to extract calculi from the deeper biliary passages by means of instruments is far greater than that of a simple incision; hence this operation should not be attempted unless the cystic duct is much dilated.

Some surgeons advocate cystostomy, to be followed a few weeks later by the removal of the calculus in the common duct. This reduces the risk of infection, but unless the condition of the patient prevents, the skilled surgeon will generally prefer to complete a choledochotomy in one operation. The operation in two stages is uncertain because the calculus may shift its position and it is more likely to be

followed by a ventral hernia. Choledochotomy carried out by a lumbar incision, as recommended by Tuffier, should only be performed in case the gall-bladder is empty, and on account of adhesions or fistulas between the gall-bladder and intestine it is absolutely impossible to reach the common duct from in front. In such a case the wound should be tamponed with sterile gauze, and two weeks later the gauze can be removed and a sound introduced to serve as a guide in making the posterior extraperitoneal incision.

Cholecystenterostomy is indicated in cases in which choledochotomy is impossible (extensive adhesions, deep situation of the common duct), or in case of chronic inflammation in the head of the pancreas. This operation should only be performed in extreme instances on account of the risk of infection from the intestine (cholangitis). In performing 137 choledochotomies Kehr has always succeeded in removing the calculus, so that he has never been obliged to resort to choledochotomy in two stages, extraperitoneal choledochotomy, or cholecystenterostomy on account of obstruction due to calculus.

Mortality.—The mortality after operations upon the biliary tract varies according to the method chosen, according to the severity of the disease, the pathological conditions, and also according to the dexterity of the operator. The fixation of an easily reached gall-bladder in the abdominal wound is as easy as a simple ovariotomy. The mortality following extirpation of the gall-bladder is about 3 per cent. That of choledochotomy varies between 7 and 26 per cent., and reaches almost 100 per cent. in cases of cholelithiasis complicated with suppurative cholangitis, or in cases of extensive carcinoma. The results of operation performed by Kehr in the last twelve years are as follows:

a. 237	Conservative operations (cystostomy, cysticotomy, cystendysis), with 5 deaths	2.1	per cent.
b. 161	Cholecystectomies, with 5 deaths	3.1	"
c. 137	Choledochotomies (for the most part with hepatic drainage), with 9 deaths	6.5	"
d. 114	Cases in which operation was at the same time performed upon the stomach, intestine, pancreas, liver, kidney, etc., with 24 deaths	21.0	"
e. 71	Operations performed upon patients found to have inoperable carcinoma of the gall-bladder, common duct, or liver, or diffuse suppurative peritonitis, or diffuse suppurative cholangitis, sepsis, etc., with 69 deaths	97.0	"
720	Laparotomies, with 112 deaths	15.5	"

The mortality, therefore, in cases not complicated with carcinoma or diffuse cholangitis is about 3.5 per cent. (535 operations with 19 deaths). Equally good results have been reported by Löbker, Czerny, Riedel, and Rotter.

After-treatment.—The after-treatment of a patient who has been operated upon for calculi must meet the various emergencies which may follow any laparotomy. It is unnecessary to describe in this place the treatment for vomiting, meteorism, and pain. There are,

however, special symptoms in these cases which require special treatment. After cystostomy one should see that the tube lies properly in the gall-bladder and discharges a constant stream of bile. If this is the case, the first dressing does not need to be changed until ten or twenty days have passed. Every bit of the silk stitches and ligatures must be removed in order to avoid incrustation. Irrigation of the gall-bladder with normal salt solution aids the patient in overcoming the catarrh of the mucous membrane. As soon as one is sure that no calculi remain behind, the biliary fistula may be allowed to close. But it is better not to hasten in this matter, as drainage of the gall-bladder is the best safeguard against recurrence of the trouble.

If the fistula continues to discharge bile more than six weeks, the reason for this should be sought:

1. Fixation of the gall-bladder to the abdominal wall may so kink the common duct as to obstruct its lumen. In such a case the gall-bladder should be freed and the opening in it freshened and sutured.

2. The fistula may become lined with mucous membrane, and so be unable to close. This is especially true in the case of very large gall-bladders, if the incision was not partially closed by suture. Treatment for this condition is separation of the gall-bladder, freshening and suture of the incision in the gall-bladder.

3. There may be calculi in the common duct. If so, the biliary fistula should be plugged with a conical peg wrapped with cotton in the hope that bile will accumulate with sufficient force to drive the calculi through the common duct. This seldom succeeds, but the plugging is of value in determining whether the continuance of the fistula is due to a kinking of the common duct. If it is, bile will pass through the common duct when the fistula is plugged; but as soon as the plug is removed, it will again come from the fistula. The same thing may happen if there are a small calculus in the common duct and a moderate amount of inflammation. In some cases it is possible to remove a calculus from the common duct by probes, irrigation, etc.; but usually a second laparotomy must be performed and the condition met by choledochotomy or cholecystenterostomy.

If a mucous fistula follows cystostomy, the cystic duct is obstructed. This may be due to a calculus or inflammation, or kinking caused by adhesions.

1. Often the mucous membrane of the gall-bladder becomes obliterated at the same time as does that of the cystic duct. No operation is then required. If a fistula persists, it may cause colicky pain because its external orifice is so small. Such pain can be relieved by a small drain. The fistula may be obliterated slowly by astringents or the Paquelin cautery. Removal of the gall-bladder is a more radical but a more certain method of cure.

2. A calculus may be fixed in the cystic duct. If it cannot be removed with curved forceps introduced through the gall-bladder, cysticotomy or cystectomy should be performed.

3. The mucous discharge may be due to swelling of the mucous

membrane of the cystic duct. Irrigation of the gall-bladder by overcoming its catarrh will often change the mucous fistula into a bilious fistula, which will then speedily close.

4. The cystic duct may be kinked by adhesions reaching to the stomach, omentum, etc. If the mucous discharge is abundant, so that it annoys the patient, the abdomen may be opened in the median line and the adhesions divided. A more radical procedure is cystectomy.

Even when the gall-bladder is removed a discharge of bile may continue for a long time. It may come from bile-ducts in the liver which were torn open by removal of the gall-bladder, or it may be due to a loosening of the ligature of the cystic duct. The flow may continue for weeks, or it may be permanent if the common duct is obstructed by a calculus or is compressed by a tumor of the pancreas. In such cases it may be necessary to reopen the abdomen and incise the common duct. In the absence of the gall-bladder this is a difficult operation. If the obstruction is due to chronic pancreatitis, it may be overcome by a cysticoduodenostomy. Kehr has performed this difficult operation three times with success.

The existence of mucous and biliary fistulas following cystostomy has occasioned some prejudice against this operation, but the operation is scarcely to be blamed for such results, as Kehr in a series of 700 laparotomies for calculi has experienced no permanent fistula.

Three complications may follow choledochotomy with or without hepatic drainage more often than they follow other operations upon the biliary tract; they are: pneumonia, acute dilatation of the stomach, and hemorrhage due to cholæmia. In Kehr's cases pneumonia occurred in about 8 per cent. of patients after these operations, but it was fatal only in aged or cholæmic or otherwise enfeebled persons. The best treatment for acute dilatation of the stomach is the frequent passage of a stomach-tube. The obstruction is often situated below the pylorus (mesenteric artery). If a changed position of the patient and the use of the stomach-tube do not relieve this condition, gastro-enterostomy should be performed. Repeated vomiting and heart failure are to be combated by gastric lavage and infusions of normal salt solution. The best way to prevent cholæmic hemorrhage is to operate early. Robson recommends the administration of calcium chloride in 2 gramme (30 grain) doses three times a day for several days previous to operation, as well as after operation. Hemorrhage from the stomach may follow an operation for calculi, as it may follow other operations. All nourishment by mouth should be stopped, morphine is given subcutaneously, the stomach irrigated with ice water or a 1 : 1000 solution of silver nitrate, while nutritive enemata containing ergot and saline injections are also useful. If the aseptic details are perfect and the technic of the surgeon is satisfactory, peritoneal infection does not follow more than 1 per cent. of operations for calculi.

The after-treatment of the patient whose common duct has been incised requires especial attention. A second operation may be required to combat hemorrhage, to remove additional calculi, to close a biliary or

mucous fistula, and to overcome adhesions to or stenosis of the pylorus or duodenum. In rare cases ileus may be the cause for the second operation. A fistula of the gall-bladder usually closes in four weeks, that of the common duct in five to six weeks. Kehr keeps a patient in bed two or three weeks, and lets him return home in four weeks wearing a properly fitting bandage to prevent hernia. He has rarely found it necessary to operate for ventral hernia. A Carlsbad cure is not absolutely necessary after operation, but it is of benefit to many patients.

The permanent results of operations for calculi are perhaps as satisfactory as those which follow any class of surgical operations. If the gall-bladder is not removed, it is conceivable that a recurrence of the trouble may take place; but as a matter of fact such recurrence rarely if ever occurs. In most cases in which calculi have been removed by a second operation they were calculi which were left at the first operation.

It is frequently impossible to remove every calculus from a patient who has been allowed to go on until choledochotomy is required. The fault in such a case lies with the physician, who looks upon an operation merely as a last resort and postpones it as long as possible. In many cases calculi have formed around portions of silk which have found their way into the gall-bladder, so that one ought never to leave any silk stitches or ligatures in it or in its vicinity.

If a patient suffers pain following an operation for gall-stones, and especially after cystostomy, such pain may be due to adhesions, or to hernia, or to renewed inflammation in the gall-bladder, or to other abnormal conditions which existed at the time of operation (movable kidney, enteroptosis). Adhesions in the form of bands are especially likely to cause pain, while adhesions between broad surfaces are not usually painful.

The permanent results of cystectomy are particularly good. This operation, especially when combined with drainage of the hepatic duct, is less likely to leave a calculus behind than is cystostomy or cholecdectomy with suture. Calculi in the common and hepatic ducts may exist without symptoms; hence if one is to obtain a radical cure by his operation he must treat the biliary passages as he treats the gall-bladder—that is, he must open and drain them. It is well not to operate unless there is a clear indication for it, but after operation is decided upon it should be performed thoroughly.

TUMORS OF THE GALL-BLADDER AND BILE-DUCTS.

The benign tumors of the biliary passages are: atheroma, fibroma, papilloma, myxoma, and echinococcus cyst. The malignant tumors are sarcoma and carcinoma. Metastatic cancer secondary to that of the liver is rare and has no surgical interest.

Carcinoma.—Primary carcinoma of the gall-bladder is relatively common. It is of two forms. One form develops from the epithe-

lium of the bile-ducts, spreads rapidly to the liver, and in the beginning is not accompanied by either ascites or jaundice. It cannot be distinguished by its symptoms from primary carcinoma of the liver. Carcinoma of the second form develops from the glandular cells of the mucous membrane of the gall-bladder and remains localized for a considerable time, causing early compression of the gall-ducts and jaundice. Carcinoma of the gall-bladder is a disease of old age, though it sometimes occurs in women before the fortieth year. Carcinoma of the gall-bladder, like cholelithiasis, is five times as common in women as in men.

Symptoms.—The early symptoms are: loss of appetite, disturbance of digestion, a feeling of pressure in the region of the gall-bladder, and pain in the back. The diagnosis is not likely to be made until a hard tumor can be felt, which as it grows larger has an uneven surface. The carcinomatous gall-bladder often becomes empyematous. The tumor will then be more or less smooth, fluctuating, and tender; and if jaundice exists, one may suspect carcinoma from the emaciation, etc., but cannot be sure of it without operation. Fever is absent, or, if present, is due to a coexisting inflammation or to a degeneration of tissue which occurs in a late stage of carcinoma. Any abdominal carcinoma may cause more or less fever in its late stages. Ascites and hemorrhage occur at a period when surgical treatment is no longer possible. Adhesions existing between a carcinomatous gall-bladder and surrounding organs are the result of a previous calculus or pericholecystitis. Carcinoma beginning in the fundus or neck of the gall-bladder extends by continuity to the cystic and common and hepatic ducts. The lymphatic glands in the neighborhood of the portal vein may become affected (ascites) or metastases may be formed in the peritoneum, liver, and other organs.

Three points are of practical importance:

1. Carcinoma of the gall-bladder is almost always preceded by or accompanied by cholelithiasis.

2. Therefore the removal of biliary calculi is the best prophylaxis against carcinoma of the gall-bladder.

3. The differential diagnosis between cholelithiasis and extensive carcinoma of the gall-bladder is only of interest in the sense that by making it one may avoid a useless operation, namely, opening the abdomen in the presence of inoperable carcinoma.

Diagnosis.—An early diagnosis of carcinoma of the gall-bladder can only be made by an exploratory incision. The more physicians advocate an early operation for calculi and do not allow them to remain in the gall-bladder for many years, the less frequently will one be called upon to operate for carcinoma. Patients who are more than forty years old, and who suffer from symptoms referable to the gall-bladder, should be watched with especial care, and if the gall-bladder suddenly increases in size without especial pain the possibility of carcinoma should be considered.

In making a differential diagnosis between calculus and advanced

carcinoma the surgeon should consider the consistence of the tumor, its palpable surface, jaundice, the general condition of the patient, and possible ascites. Usually a carefully taken history will afford much material for a correct diagnosis. In cases of carcinoma even when accompanied by calculus the pain is apt to be of a dull character. If, however, inflammation or suppuration is added, there may be intense colicky pains.

Treatment.—Attempts to cure a patient of carcinoma of the gall-bladder have not been very successful, nor are they likely to become so unless means are discovered for making an earlier diagnosis. Hochenegg, in 1889, removed a carcinomatous gall-bladder together with a wedge of hepatic tissue. Three years later the patient died of recurrence. Several similar operations have since been reported with similar results. If the lymphatic glands about the portal veins are affected, radical operation is out of the question. If the disease is confined to the gall-bladder, its removal may be possible. The adjacent portion of the liver and lymphatic glands along the cystic and common ducts should also be excised. If a carcinomatous gall-bladder suppurates, intense pain can be relieved by cystostomy. However, this operation by exposing the carcinoma hastens the gangrene of its surface.

Operations for carcinoma have the unfortunate result of bringing all operations upon the gall-bladder into more or less disrepute, since the laity do not distinguish between operations for carcinoma and those for calculi.

Various tumors may develop in the biliary ducts (lipoma, adenoma, sarcoma, carcinoma) and obstruct their lumen. Obstruction may also be due to outside pressure, as from echinococcus of the liver, carcinoma of the pancreas, aneurism of the hepatic or superior mesenteric artery, lymphoma, carcinoma of the pylorus, etc. If a tumor within the common duct has a pedicle, it may produce the same symptoms as a movable calculus.

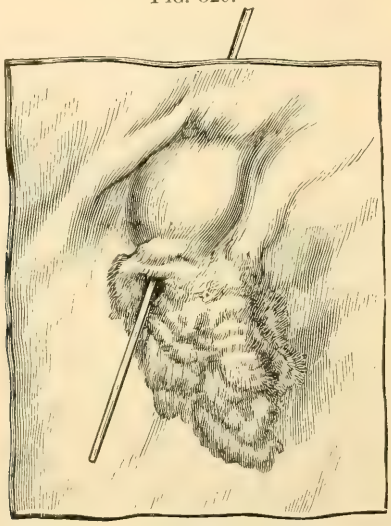
Primary carcinoma of the bile-ducts starting from their epithelium is especially frequent in the papilla of the duodenum or the juncture of the cystic and common ducts, or at the bifurcation of the hepatic duct. (Fig. 329). The carcinoma is usually of the scirrhous type. The gall-bladder is usually obliterated, but calculi are not so often an accompaniment as they are in cancer of the gall-bladder. Jaundice in the beginning is slight; later it becomes intense. Pain may be wholly wanting. There are disturbance of digestion, loss of appetite, etc. The liver is enlarged and presents in time the appearance of biliary cirrhosis. Carcinoma of the common duct occurs two or three times as frequently in men as in women. Differential diagnosis between obstruction of the common duct due to tumor and that due to a calculus has already been given.

Leichtenstern places especial weight upon enlargement of the jugular lymphatic glands as a diagnostic sign in these cases of carcinoma. The glands of the left side are more often affected than those of the

right. Other observers have not found this sign to possess diagnostic importance ; at any rate, not in the early stages.

If the diagnosis of carcinoma of the bile-ducts can be made early, the growth should be radically removed. Such an operation presents technical difficulties, but they may perhaps be overcome. Carcinomata of the common duct and of the papilla have been successfully operated upon. Unfortunately, early diagnosis is well-nigh impossible, and when jaundice is present only a palliative operation can be performed. The best one for carcinoma in the common duct or papilla is cholecystenterostomy. If the tumor is situated at the mouth of the cystic duct or at the bifurcation of the hepatic duct, there is nothing to be gained by an anastomosis between the gall-bladder and intestine,

FIG. 329.



Adenocarcinoma of duodenal papilla; no metastasis.

while anastomosis between some dilated branch of the hepatic duct and the intestine would be too serious an operation for a person already so nearly exhausted. Dilatation of the stricture caused by carcinoma of the hepatic duct gives no permanent relief.

It is worth remembering that an inflammatory process in the head of the pancreas may produce a very hard tumor easily mistaken for carcinoma. Cholecystostomy, drainage of the hepatic duct, and cholecystenterostomy are operations which in such circumstances may afford the patient permanent relief. If the tumor of the head of the pancreas is positively known to be carcinomatous, any radical or even palliative operation is scarcely worth undertaking. However, the operator should bear in mind the fact that chronic inflammation of the pancreas has been mistaken for carcinoma by experienced surgeons.

INJURIES AND DISEASES OF THE SPLEEN.

Anatomy.—The concave inner surface of the spleen is directed toward the fundus of the stomach and the upper pole of the left kidney, while its convex surface is directed toward the diaphragm, to which it is attached by a fold of peritoneum (the suspensory ligament). The organ lies under the ninth, tenth, and eleventh left ribs, and its long axis is directed from above downward and forward. Its upper end is placed at the level of the tenth dorsal vertebra close under the arch of the diaphragm, so that it is separated from the lung merely by the diaphragm with its two serous coverings, the peritoneum and pleura. For this reason an abscess of the spleen can easily break into the pleural cavity. Between the stomach and spleen there is an extension of the great omentum which is known as the gastrosplenic omentum. Behind this membrane are placed the splenic artery with its five to seven branches and the splenic vein. The peritoneum, which covers them posteriorly, forms part of the anterior wall of the lesser peritoneal cavity. The suspensory ligament of the spleen extends from the left pillar of the diaphragm. Its plane is the same as that of the long axis of the spleen, which again is almost identical with that of the tenth rib.

The spleen is best exposed by an incision along the outer border of the rectus muscle and a transverse incision parallel to the costal margin, or by a lumbar incision similar to that used to expose the kidney. Sometimes, in the case of abscess, it is necessary to resect a portion of the ninth, tenth, and eleventh ribs, and to open the pleural cavity and cut through the diaphragm. In removing tumors of the spleen it is well to remember that the ligaments of the spleen are very extensive and contain numerous large bloodvessels. Its pedicle often requires several ligatures. Absence of the spleen, congenital anomalies, and accessory spleens are conditions of no surgical interest.

CHAPTER XXVI.

INJURIES OF THE SPLEEN.

TRAUMATISMS OF THE SPLEEN.

THERE are subcutaneous injuries of the spleen (contusion and rupture) and open wounds of the spleen, either stab-wounds or gunshot-wounds. Edler's statistics comprise 160 cases of injury, 51.8 per cent. of which were subcutaneous, 26.2 per cent. gunshot-injuries, and 21.8 per cent. incised wounds. Berger's collection of cases shows that 300 men were injured and only 60 women.

Etiology.—Diseases which enlarge the spleen, such as malaria, miliary tuberculosis, and typhoid fever, play an important part as predisposing factors to subcutaneous injury. A healthy spleen is rarely ruptured subcutaneously. Congenital syphilis predisposes to rupture of the spleen during birth. Among the rare cases of subcutaneous rupture may be mentioned violent contraction of the abdominal muscles and diaphragm during sneezing or vomiting, while the spleen of a very cachectic patient has been ruptured by palpation of the abdomen.

The usual causes of subcutaneous rupture are falls, kicks, and the passage of a wheel across the abdomen. Gunshot-wounds and stab-wounds are on the whole not common. The spleen has several times been injured unintentionally by a trocar thrust into the abdomen for the relief of ascites. In one case in which an attempt was made to aspirate a supposed echinococcus cyst of the spleen a bloodvessel was ruptured with fatal result. There are on record several cases of rupture of the spleen during pregnancy and during childbirth. At least five patients who have suffered this accident have been saved by removal of the injured spleen.

Pathological Anatomy.—A contusion of the spleen may terminate in abscess, or a simple cyst, or leukemic enlargement of the organ. Ruptures of the spleen are of various depths. Lamarchia says that the hilus is especially likely to rupture. Usually the capsule and parenchymatous tissue tear together, and unless the parts are surrounded by adhesions blood flows into the peritoneal cavity. If adhesions are present, a circumscribed hæmatoma results. If the substance of the spleen is ruptured while the capsule remains intact, an intracapsular hæmatoma results which may strip up the whole capsule of the spleen. If the injury is slighter, one or more hemorrhagic foci will result in which the tissue of the spleen exists in a pulpy condition. These foci may become transformed into abscess cavities or they may shrink and calcify. If they extend to the surface of the spleen and

the organ becomes adherent, rupture may take place into the stomach, colon, pleural cavity, or pelvis of the kidney.

Symptoms.—There are no symptoms pathognomonic of injury of the spleen. The usual results of a contusion are pain and enlargement of the spleen. If the spleen is ruptured, the symptoms of internal hemorrhage place all other symptoms in the background. The pain in subcutaneous injuries is noticed at first in the left side, but soon it spreads to the whole abdomen. There are added symptoms of collapse, marked pallor, small pulse, chilliness, and a feeling of exhaustion. In rare instances the spleen may be ruptured without giving rise to any symptoms. Sometimes the vagus is affected owing to a connection of the splenic plexus with the semilunar ganglion, and as a result there are symptoms connected with the lungs or heart or the larynx (hoarseness, or possibly complete loss of voice). The blood which escapes may spread throughout the whole abdomen or it may be more or less limited by pre-existing adhesions. If the spleen which is ruptured was enlarged, it may, if the capsule is also torn, become smaller; on the other hand, if the spleen is ruptured and the capsule remains intact, a palpable tumor may result. There are usually symptoms of disturbed respiration and digestion. Some writers speak of a peculiar waxy color of the face with a brownish-green tint, which they say is pathognomonic of rupture of the spleen. Vomiting of blood and bloody stools following rupture of the spleen when there is no blood in the peritoneal cavity is a sign that the stomach or intestine, being adherent to the spleen, has suffered rupture conjointly with the latter organ.

Diagnosis.—It is only occasionally that one can make a diagnosis of contusion or rupture of the spleen. Usually the surgeon must content himself with the diagnosis of intraperitoneal hemorrhage unless a splenic tumor which was known to exist before injury has become smaller. A correct diagnosis is most likely to rest upon accurate description of the position of the patient and the character of the injury.

In case of open wounds the site of the wound and the character of the hemorrhage are to be noted. Hemorrhage from the abdominal wound is rare in the case of gunshot-wounds of the spleen. In about 70 per cent. of gunshot-wounds of the spleen the diaphragm is also injured. If the external wound is very large and the ligaments of the spleen are long, the organ may be forced into the wound by the contraction of the diaphragm. Such a prolapse may occur through a wound which seems too small to have permitted the exit of the spleen. This is partly due to the elasticity of the organ and partly to the enlargement which takes place after prolapse as a result of venous congestion. Prolapse is not usually accompanied by hemorrhage, both because the prolapsed spleen is generally an uninjured spleen, and because the pressing of the spleen into the abdominal wound stops hemorrhage from the abdominal wall. Unless the spleen is replaced, it becomes gangrenous with more or less rapidity according to the amount of constriction of its pedicle.

Prolapse of the spleen is easily recognized, and unless there are other injuries or hemorrhage from a portion of the spleen which is not exposed to view the prognosis is favorable. Ledderhose states that recovery occurred in 29 of 32 cases, the treatment being reposition, or partial or total extirpation. Berger reports 8 cases treated by reposition, 13 by resection of the prolapsed portion, and 20 by removal of the whole spleen. All the patients excepting 1 recovered.

Treatment of Prolapse.—If a patient with prolapsed spleen is seen soon after the injury occurred and the organ is sound, it should be thoroughly cleansed and returned to the abdominal cavity. If for any reason asepsis cannot be perfectly carried out, it is better to remove the spleen. If the prolapse is a partial one, the affected part of the organ may be excised and the wound of the spleen sutured. The abdominal wound in such circumstances should be tamponed.

Contusion of the spleen unless followed by abscess or a cyst usually terminates in recovery. The outlook for a patient whose spleen is ruptured is far less favorable. Edler estimates that the mortality is about 75 per cent. from hemorrhage and 10 per cent. from peritonitis. Berger places the mortality as high as 92.6 per cent. in rupture of the spleen, one-half the patients dying within an hour after the injury, and most of the remainder within twenty-four hours.

Treatment of Contusions and Ruptures.—A patient who suffers from contusion of the spleen should be treated by ice both internally and externally ; and if a cyst or abscess develops, it should be opened, or the spleen removed. (Page 709.)

Rupture of the spleen requires the same treatment as rupture of the liver, to which the reader is referred. (Page 634.) The abdominal incision should be long. It may be made in the median line or at the outer border of the left rectus muscle, or a transverse incision may be preferred. If the spleen is sufficiently exposed and its tissue is firm, the rupture may be sutured. One should be certain, however, that a second rupture does not exist, otherwise he may lose his patient from hemorrhage. This happened to Lamarchia, who states that the inner surface of the spleen behind the gastrosplenic ligament is a favorite seat for rupture. Madelung succeeded in suturing a ruptured and bleeding spleen into the pleural cavity. He resected a portion of the thorax-wall and reached the spleen through an incision in the diaphragm. Several other surgeons have reported successful suture, although the number of successes following extirpation for rupture is far greater. Berger collected reports of 130 operations of this character, 77 of which were followed by recovery (59.2 per cent.). Expectant treatment was followed by recovery in only 7.4 per cent. Expectant treatment after gunshot-wounds was followed by recovery in 10 per cent. of the cases, and after incised wounds in 21.4 per cent. The results of operations recently performed are far better than those of even ten years ago. Thus recovery followed in 73.3 per cent. of 45 operative cases treated in 1900 and 1901.

CHAPTER XXVII.

DISEASES OF THE SPLEEN.

ABSCESS OF THE SPLEEN.

Etiology.—The acute inflammation and swelling of the spleen which occurs so often in connection with infectious diseases possesses no practical interest for the surgeon. The reverse is true of abscess, which may be idiopathic and primary, but is generally secondary. Injury and excessive muscular exertion are given as causes of primary abscess, while secondary abscesses are for the most part the result of embolic infarcts (endocarditis) and metastatic inflammation occurring in connection with pyæmia, typhoid fever, acute rheumatism, and malarial fever.

Pathological Anatomy.—An abscess of the spleen is apt to be situated in its upper portion, and to present on the outer surface or along the anterior margin. It varies in size from that of a walnut to that of a hen's egg. Much larger abscesses may result from the union of several suppurating infarcts and the destruction of intervening splenic tissue.

Sometimes an abscess rapidly destroys tissue, produces marked septic symptoms, and leads quickly to death. At other times it runs a chronic course with few symptoms. The abscess that is usually observed reaches the capsule of the spleen and then produces a variety of symptoms according to the direction of the pus after it breaks through the capsule. If the spleen becomes adherent to the stomach, or intestine, or kidney, or diaphragm, or abdominal wall, it may break into one of these organs, or externally, without infecting the peritoneal cavity. Indeed, suppurative peritonitis from splenic abscess is rare. Pyæmia, due to emboli discharged through the splenic vein, is another rare outcome of splenic abscess. The pus may break through the posterior peritoneum and extend behind the descending colon to the anus or vagina.

It is worth noting that a pathological examination of the pus from a splenic abscess has sometimes failed to reveal the presence of micro-organisms. This fact may explain the latent course which these abscesses sometimes exhibit.

Diagnosis.—It is rarely possible to make a diagnosis of splenic abscess situated centrally in the spleen, although this condition should be considered if during typhoid or malarial fever the temperature rises, splenic tumor increases, and pain develops. Usually pain is not noted until the abscess reaches the capsule, nor is fever a constant

symptom. Fluctuation cannot be made out unless the abscess is a large one. If the abscess is not relieved spontaneously or by an operation, it will produce chills with afternoon fever, profuse sweat, loss of appetite, diarrhœa, emaciation, and death. Additional symptoms of splenic abscess mentioned by Lauenstein are: a high position and fixation of the left half of the diaphragm and a basal pleuritic friction-sound. If the pus breaks through the capsule of the spleen, the splenic tumor will become immediately smaller or disappear, and the presence of the pus can be made out in the stomach or pleural cavity. External rupture will be preceded by œdema and an increased tenderness of the abdominal wall. Rupture into the peritoneal cavity will produce the symptoms of diffuse suppurative peritonitis.

Prognosis.—In abscess of the spleen prognosis depends upon the cause of the abscess and the direction in which the pus extends. Rupture into the stomach is a relatively favorable outcome. In general if the condition of the patient is good and surgical aid is promptly summoned, recovery should be looked for.

Treatment.—The abscess may be opened and drained, or, if the spleen is in a large measure destroyed, it should be removed. A large abscess may be reached through an incision made along the left costal margin. If the abscess is smaller, it may be necessary to resect portions of two or three ribs and to cut through the diaphragm. Bessel-Hagen in 2 cases reached and drained an abscess of the spleen by a resection of the tenth rib and its cartilage without opening the pleural cavity. In operating through the pleural cavity one may complete the operation in one stage if the layers of pleura have become united by the inflammation, otherwise it is better to postpone the completion of the operation until such adhesions have formed. If the abscess has already broken through the capsule, the position of the pus must determine the site of the external incision. An attempt should be made to reach it as directly as possible so as thoroughly to drain the abscess cavity. Primary splenectomy for abscess is an operation which has not often been performed on account of the exhausted condition of the patient. It is better first to drain the abscess; afterward, if suppuration continues, to remove the spleen.

An exploratory puncture to determine the presence of pus is only permissible in case it is followed immediately by operation. Compare what has been said on this subject in connection with empyema of the gall-bladder and echinococcus of the liver.

TUMORS OF THE SPLEEN.

Non-parasitic Cystic Tumors.—The multiple cysts occasionally found in amyloid degenerated spleens have no surgical importance. Serous cysts and cysts containing bloody contents have sometimes been treated by operation. Such cysts are probably due to hemorrhage; a cause of non-parasitic cysts already spoken of in connection with

the liver. Of course, hemorrhage may take place in a simple serous cyst. Dermoid cysts of the spleen are also described.

A small cyst of the spleen gives rise to no symptoms. A larger one produces symptoms by pressure upon the stomach, intestine, lung, etc. Fluctuation cannot be made out unless the cyst is large.

A cyst of the spleen must be differentiated from one of the kidney, of the pancreas, of the mesentery, or of the pleura, and from echinococcus cyst of the left lobe of the liver. The area of the dulness on percussion, the shape of the tumor, and the history of its growth may aid in establishing the diagnosis. The examination of fluid obtained by aspiration will distinguish non-parasitic cysts from parasitic cysts, but the objections to this procedure are great, as stated on page 648. The treatment of the two kinds of cysts is, moreover, essentially the same.

Parasitic Cysts of the Spleen.—The animal parasites which may be found in the spleen are: cystocercus, pentastoma, and echinococcus. Only the last named occurs with sufficient frequency to merit a description.

Echinococcus of the spleen forms from 1 to 3 per cent. of human echinococcus. The cyst may develop in the centre or near the periphery of the organ, or it may become pedicled, or even completely separated. It grows at the expense of the spleen, which may completely atrophy as a result. There are often adhesions between the degenerated spleen and the stomach, intestine and omentum, diaphragm, or abdominal wall.

Symptoms and Diagnosis.—Echinococcus of the spleen forms a cystic tumor whose limits can be made out by palpation and percussion unless they are obscured by extensive adhesions. In such circumstances the diagnosis may be difficult. Hydronephrosis of the left side may be differentiated by the history (blood in the urine), by a cystoscopic examination, by distention of the colon, etc. An echinococcus cyst usually fluctuates, but rarely gives a hydatid thrill. If the cyst-wall is tense or thick, or if the cyst is deeply situated, it may be impossible to make out the fluctuation. A peritoneal friction-sound is not pathognomonic of this disease, since it may occur in connection with perisplenitis due to other causes. Any echinococcus perisplenitis is usually secondary to suppuration, the symptoms of which are increased tension of the cyst, with pain and increased temperature. In differentiating echinococcus cyst from other tumors of the spleen one should bear in mind the slow growth of the cyst, the slight disturbance of general health in the beginning of the disease, and in the later period the disturbance of function of the stomach, intestine, and lungs, according to the direction of growth of the echinococcus. Examination of the blood will indicate the presence of a leukemic splenic tumor, while the patient's history will indicate the probability of enlargement due to malaria. The danger from exploratory puncture has been already mentioned.

Prognosis.—Echinococcus of the spleen when treated peritoneally

has a relatively favorable diagnosis. Without operation the condition may terminate spontaneously, or go on to perforation into the transverse colon, or into the stomach or pleural cavity or peritoneal cavity.

Treatment.—Puncture and injection of an echinococcus cyst of the spleen had better never be performed. The proper treatment is incision complete in one or two stages. Mosler collected records of 12 operations, for the most part punctures, with 6 deaths and 6 recoveries. According to Trinkler, the mortality in the pre-antiseptic period was 42 per cent., and in the antiseptic period 22 per cent. Hahn says the diagnosis is good when adhesions are slight or absent. If the spleen is only moderately movable, the best treatment is incision in one or two stages. If it is freely movable and atrophied, splenectomy should be performed. Partial resection should not be performed unless the line of incision is certain to be easily accessible. Billroth's method of evacuating the contents of the cyst, filling it with iodoform-glycerin, suturing and dropping it back into the abdominal cavity, is a risky procedure. If the spleen is adherent to the abdominal wall in such a way that the peritoneal cavity need not be opened, there is no especial risk in an operation completed at once. According to Bessel-Hagen, splenectomy for echinococcus before 1890 had a mortality of 60 per cent., and 10 per cent. from 1891 to 1900. In spite of these figures incision seems preferable to splenectomy in most cases.

Solid Tumors.—Lymphangioma, cavernous angioma, fibroma, enchondroma, osteoma, myxoma, and lipoma are forms of solid tumors which rarely occur in the spleen. Primary carcinoma is doubtful. Metastatic nodules secondary to carcinoma of the stomach are without surgical interest. Melanosarcoma and lymphosarcoma are the forms of tumor most frequently encountered. There are on record 9 cases of removal of the spleen on account of sarcoma, with 3 deaths. The diagnosis of this condition is not easily made. It is suggested by a rapid increase in the size of the organ, by a rough surface and severe pain, especially if these symptoms are present in a patient whose blood is unaltered, who gives no history of malaria, and in whom there is no irregular fever.

Other enlargements of the spleen than those due to a distinct new growth may require surgical treatment. Such are the leukæmic spleen, simple hypertrophy of the spleen (Figs. 330 and 331), malarial spleen, the spleen of congestion and amyloid disease, tuberculosis and actinomycosis of the spleen. The differential diagnosis of these conditions is given in text-books on internal medicine.

Treatment.—Experiments upon animals and observations upon healthy men whose spleens have been removed on account of traumatism show that the removal of the spleen does not necessarily affect the health of the individual. In some cases it is followed by a temporary increase in the white blood-corpuscles, decrease in the red blood-corpuscles, and a reduced percentage of hæmoglobin in the blood. Opinions differ as to the effect upon the lymph-glands, thyroid gland,

and the bone-marrow. Whatever may be the exact physiological function of the spleen, it is certain that its removal is followed by only slight disadvantages of a temporary nature.

The chief danger of splenectomy is from hemorrhage. This is especially true in leukæmia, since the blood of a leukæmic patient possesses less than the normal power of coagulation. Furthermore, the separation of adhesions in persons not leukæmic often produces dangerous hemorrhage. In the ligation of the pedicle especial care should be taken to prevent the ligatures from slipping. The spleen itself contains such a mass of blood that its removal means a considerable loss to the body, and this should be borne in mind in estimating

FIG. 330.

Primary splenomegaly. Front view. The dotted line marks the outline of the spleen. (Brill.)

FIG. 331.

Primary splenomegaly. Side view. (Brill.)

the effect of operation. Péan considers that the removal of a spleen weighing 7 or 8 kilos (14 or 16 pounds) means a loss to the body in blood of at least 2 kilos (4 pounds). Such a loss is no trifling matter to the organism. The removal of an enlarged spleen also disturbs the abdominal circulation in such a manner that it may even cause death. The prognosis of splenectomy depends not a little upon the mobility of the spleen. If the spleen is adherent beneath the ribs and the adhesions will not stretch, the operation is more difficult and dangerous. This is especially true of adhesions between the spleen and the diaphragm.

With these general points in mind, it is necessary to determine in each individual case whether splenectomy is justifiable.

The removal of a leukæmic spleen may accomplish two objects: the cure of the disease and the removal of an annoying tumor. Leukæmia is primarily a disease of the bone-marrow, while the changes in the spleen and lymphatic glands are of a secondary nature. A simple splenic leukæmia is so rare that it need not be considered. Therefore, it is hardly possible to exert a favorable influence upon leukæmia by removal of the spleen. Nor is the removal of the enlarged spleen worth the risk of the operation. These patients have such a tendency to bleed that the incision in the abdominal wall may give trouble, while the division of the attachments between the spleen and diaphragm is certain to produce a fearful hemorrhage. Most patients of this sort who have been operated upon bleed to death within a few hours. If the spleen is only moderately enlarged and the blood-changes are not marked, splenectomy is possible. But in such circumstances the spleen as a tumor does not usually produce serious symptoms. It is fair to state therefore that in leukæmia splenectomy has little to recommend it, and that in the advanced stages of the disease it is a very dangerous operation. Vulpius mentions 28 cases of splenectomy in leukæmia, with 25 deaths from hemorrhage. One patient survived operation for thirteen days and one for eight months, both dying from increased leukæmia, and it seems doubtful whether the sole remaining patient, who permanently recovered from the operation, ever had leukæmia.

In simple hypertrophy of the spleen not due to malaria splenectomy has been performed with good results, but patients in whom it has occurred are often weakened by other diseases, such as syphilis and tuberculosis, so that they are not always in a condition to withstand the operation. When they have done so, it seems doubtful how much they have been benefited. If the spleen is very large and produces symptoms by pressure upon neighboring organs, its removal will, of course, bring about relief to the patient.

In malaria splenectomy is only worth considering if the patient is in fairly good condition and the tumor is not large. In such circumstances there is reason to hope for improvement from continued medical treatment. If in spite of this the symptoms grow worse, operation is indicated. Bessel-Hagan cites 69 cases of splenectomy for malaria since 1891, with a mortality of only 8.7 per cent. Even after malarial cachexia is established, operation has proved of benefit in some cases. It should be borne in mind that the removal of the spleen does not in any way protect the patient from further attacks of malaria. Parona has markedly reduced the size of the spleen in malaria by subcutaneous injections of iodine (iodine, 1 part; potassium iodide and guaiacol, 10 parts; glycerin, 100 parts).

Secondary enlargement of the spleen due to congestion or amyloid disease is no indication for splenectomy. Three splenectomies for primary tuberculosis, with 1 death, are on record, and 1 successful splenectomy for syphilis. Internal treatment will usually reduce the size of a syphilitic spleen.

Hypertrophy of the spleen associated with interstitial hepatitis has been treated by splenectomy in 16 cases, with 13 recoveries. (Bessel-Hagen.)

The mortality of splenectomy varies according to the different diseases for which it is performed, but it has grown decidedly less in the last few years. Thus according to Bessel-Hagen, 97 splenectomies previous to 1897 had a mortality of 42.2 per cent., and 164 splenectomies performed between 1890 and 1900 had a mortality of 18.9 per cent. Still better results may be expected as the technic and exact diagnosis improve.

Technic of Operation.—The patient is prepared as for laparotomy. A median incision, or one along the outer border of the left rectus muscle, is usually employed, although some operators add a transverse incision to the vertical one. The object of the incision is to expose the pedicle of the spleen and to make the separation of adhesions easy. The operator stands at the left side of the patient and passes his left hand through the abdominal incision in order to determine the presence of adhesions, especially between the spleen and diaphragm. Those between the spleen and colon or omentum are more easily reached and ligated. In the separation of adhesions it is better to injure the diaphragm or even the pleura rather than to tear the tissue of the spleen which bleeds so readily. As far as possible adhesions should be tied in two places and divided between the ligatures. If they are very extensive, the removal of the spleen had better not be attempted. Experience in this direction, as in so many others, reduces the risk to the patient materially. Adhesions between the omentum, colon, or abdominal wall are best separated or ligated with silk and divided. Some operators employ the cautery for this purpose. As the pedicle contains the splenic artery and vein, its ligation requires special care, and should usually be carried out after the spleen is brought out through the abdominal wound. One should avoid seizing the spleen with instruments, as fatal hemorrhage has resulted from this mistake. The pedicle should be ligated in sections, and Billroth includes in the ligatures the tail of the pancreas so that they will not slip off. Martin leaves attached to the pedicle a bit of the spleen for the same purpose. The wound may or may not be tamponed. A tampon should be employed in all cases in which there is bleeding or torn adhesions, or in which a space is left by the removal of the spleen not directly filled by the other organs. If the hemorrhage is completely stopped by ligatures and sutures, the abdominal cavity may be completely closed. A firm dressing should be applied and the patient carefully watched for post-operative hemorrhage.

Partial ligation of the splenic vessels has been performed in an attempt to cause atrophy of an enlarged spleen, but this is an operation as difficult and dangerous as splenectomy, and while it will not be followed by hemorrhage it may be followed by gangrene.

Aneurism of the splenic artery is a rare condition that may be cured by splenectomy. Tuberculosis and syphilis do not often require

surgical treatment. Actinomycosis is one of the causes of suppuration within the spleen, and it is well to examine the pus of a splenic abscess for the characteristic actinomycotic grains.

MOVABLE SPLEEN.

The spleen is kept in its normal position by ligaments from it to the stomach and to the diaphragm, and from the diaphragm to the colon. It moves with respiration and with the motions of the stomach during digestion. If it is found in portions of the abdomen where it does not normally belong, the condition is spoken of as movable spleen. (Fig. 332.)

Fig. 332.

Wandering spleen. (Stierlin.)

Etiology.—If the spleen enlarges as a result of malaria, leukæmia, etc., its ligaments are necessarily stretched. It sinks toward the left iliac fossa, and may even reach into the right iliac fossa (hypertrophic movable spleen). If there are no adhesions, it can be pushed back into its normal situation. Such is the typical movable spleen. If it is fixed by adhesions in an abnormal position, it is spoken of as an adherent dislocated spleen. Abnormal length and elasticity of the

gastrosplenic and suspensory ligaments are the chief causes of movable spleen, while pregnancy, childbirth, relaxed abdominal walls, and the other conditions which predispose to enteroptosis all favor mobility of the spleen. This condition is much more often seen in women than in men. Movable spleen is often secondary to movable kidney of the left side since the kidney is one of its normal supports. The mobility develops gradually in most cases, but it may come on suddenly as the result of traumatism.

Pathological Anatomy.—The displaced spleen is usually found in the left iliac fossa, less often in the region of the umbilicus or pelvis or right iliac fossa. It may even be found in the sac of an inguinal hernia. It frequently becomes adherent in its normal situation. Twisting of its pedicle may interfere with its blood-supply so that atrophy or softening results. Usually such an alteration goes on aseptically, although it may produce peritonitis. The spleen has been found in congenital diaphragmatic and umbilical hernia.

Diagnosis.—If the dulness normally due to the spleen is wanting, and if a movable tumor is palpable with a hilus directed upward and to the left and with pulsating vessels, the diagnosis is easily made. If the spleen is adherent in an abnormal position, the diagnosis is more difficult. If it is situated in the pelvis, bimanual examination will be of service. It may be mistaken for fecal accumulation in the sigmoid flexure, for a movable kidney, for an ovarian tumor, or for extrauterine pregnancy. Twisting of the pedicle of a movable spleen produces characteristic symptoms (intense pain, peritonitis) whose cause is easily recognized if it is known that the patient possesses a movable spleen.

Prognosis.—The prognosis is on the whole favorable since only in exceptional cases does a movable spleen cause intense pain, disturbances of digestion, etc.

Treatment.—Radical treatment is seldom called for. If the patient has had malaria, attempts should be made to reduce the size of the spleen by quinine, etc., while a bandage should be applied to hold the spleen in place. For this purpose an operation may be performed and the spleen sutured in its normal relations or removed. If the spleen is not diseased, the former operation is certainly to be recommended. If it is diseased and hypertrophied, or if the twist in the pedicle has altered its structure, it should be removed.

The passage of a suture through the substance of the spleen has in some instances produced dangerous hemorrhage. Moreover, the suture easily tears out. For this reason Rydygier loosens the parietal peritoneum so as to make a pocket into which he tucks the spleen. This operation is performed as follows: A median incision is made and the spleen replaced in its normal position so that the operator shall know where and how large to make the peritoneal pocket. The spleen is then pushed out of place and a transverse incision corresponding to the transverse diameter of the spleen is made in the neighborhood of the ninth, tenth, and eleventh ribs through all the layers of the abdominal

wall. The peritoneum is stripped up both below and above this incision; the spleen is placed in the pocket thus made, and fixed there by sutures passed through the parietal peritoneum and suspensory ligament of the spleen. Additional fixation can be secured by sutures through the margin of the spleen itself or by scraping its lower end in order to set up granulations.

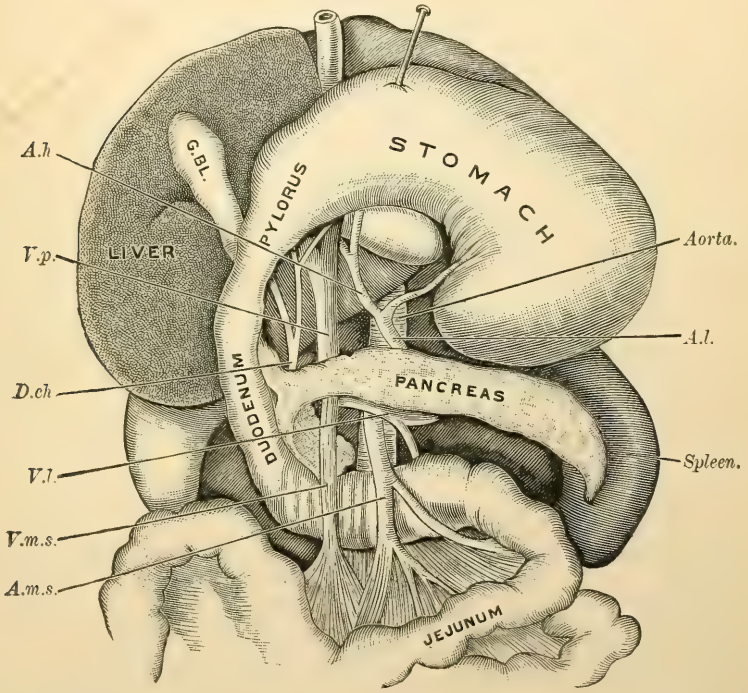
If a movable spleen is hypertrophied or contains a tumor, it should be removed. The extirpation of a movable spleen has, according to Stierlin, a mortality of only 6.25 per cent. Some surgeons have preferred splenectomy to splenopexy, the former operation being easier to carry out, being an absolute cure and having, as above stated, a slight mortality. Certainly in twisting of the pedicle splenopexy ought never to be performed unless operation is undertaken within a very short time.

INJURIES AND DISEASES OF THE PANCREAS.

By Prof. W. KORTE.

Anatomy and Physiology.—The pancreas is accessible in several ways. The gastrocolic omentum may be divided between ligatures and the stomach and transverse colon separated. (Fig. 333.) The pancreas

Fig. 333.

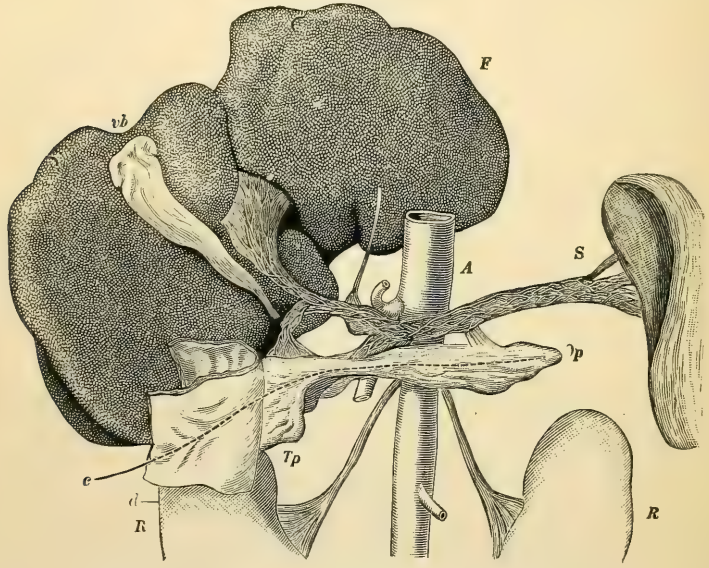


Upper portion of the peritoneal cavity of a child. The liver is drawn upward, the gastrocolic ligament is divided, the stomach is drawn upward and the colon downward. The whole peritoneum is removed. *A.m.s.*, superior mesenteric artery; *V.m.s.*, superior mesenteric vein; *V.l.*, splenic vein; *D.ch*, common bile-duct; *V.p.*, portal vein; *A.h.*, hepatic artery; *A.l.*, splenic artery. (Henle.)

will then be discovered loosely covered by the posterior peritoneal layer of the lesser omental cavity. Through this incision the whole of the

pancreas is exposed. A portion of it is accessible above the lesser curvature of the stomach after the gastrohepatic ligament is divided. If the omentum and transverse colon are drawn upward as in performing posterior gastro-enterostomy, the tail of the pancreas is visible covered by the transverse mesocolon, which may be torn through between its arteries, the large left colic artery being avoided; or the peritoneum which lies to the right of the duodenum may be torn through, the duodenum itself being pushed toward the median line and the head of the pancreas exposed in this manner. The pancreas may also be reached retroperitoneally through an incision in the right or better in the left loin. Fig. 334, drawn from nature to illustrate a case of arrested development of the pancreas, gives a good idea of the relations of the liver, pancreas, and spleen.

FIG. 334.



Aplasia of the pancreas: *Tp*, head of pancreas; *Qp*, tail of pancreas; *c*, probe in canal of Wirsung; *d*, duodenum; *F*, liver; *vb*, gall-bladder; *S*, spleen; *RR*, kidneys; *A*, aorta. (Lancereaux.)

The choice of method depends chiefly upon what portion of the pancreas is to be exposed. If a tumor or abscess has pushed its way up under the lesser curvature of the stomach, it may properly be reached in that situation; but usually both tumors and inflammatory lesions develop in the cavity of the lesser peritoneum and are best reached after division of the gastrocolic omentum. There are other cases in which the infracolic or retroperitoneal or lumbar route affords advantages.

The relations of the common duct to the pancreas are of the greatest importance. This duct lies in a gutter of the head of the pancreas,

or sometimes in a canal, so that a tumor or inflammatory swelling of the head of the pancreas can easily compress the duct.

In a few instances the head of the pancreas has been found to surround the duodenum. This condition is spoken of as annular pancreas. Accessory pancreas in the wall of the stomach or intestine is another recognized anomaly.

The secretion of the pancreas is a clear, watery, sticky fluid with alkaline reaction. It contains a good deal of albumin and its concentration varies between wide limits. It contains three ferments: a diastatic ferment, capable of splitting up and emulsifying fats, and a ferment capable of transforming albumin in peptone. The ferment which emulsifies fat is found only in the pancreas. According to Abelmann, the removal of the pancreas from a dog interferes with the resorption of albumin and stops entirely the resorption of fats which are not emulsive. Intestinal bacteria seem to be capable of splitting up fats to a certain degree.

Minkowski and Mehring made the important discovery that removal of the pancreas in animals is followed by diabetes.

General Symptoms.—Our knowledge of diseases of the pancreas is limited, although the gland has important functions in connection with nutrition, and is doubtless more often affected in diseases of the intestinal and biliary tracts than surgeons have any idea of. There are unfortunately no means of recognizing any but very severe diseases of the pancreas.

Thus far pathognomonic symptoms of pancreatic disease are but ill defined. The presence of sugar in the urine raises a suspicion of pancreatic disease, but nothing more. In many cases of diabetes no change in the pancreas can be recognized, while, as stated, the pancreas may be completely destroyed without causing the appearance of sugar in the urine. Irregularities in the resorption of fat, and especially in the splitting up of fat, also suggest disease of the pancreas. But so-called fatty stools are in no sense pathognomonic, since they occur in other diseases and may not be present in diseases of the pancreas. Failure of the organism to make use of the albumins of food, and especially the presence of great quantities of muscle-fibre in the stools, suggests disease of the pancreas.

If jaundice is present without symptoms of calculus, or if there is a distended gall-bladder, one should think of compression of the common duct by means of a tumor. Such a tumor may exist in the gall-duct itself, in the papilla of the duodenum, or, more frequently, in the head of the pancreas. Carcinoma of the pancreas is sometimes accompanied by bronzing of the skin, a symptom which is not unknown in carcinoma of other organs. Spontaneous colicky pains and pains on pressure in the epigastrium are symptoms of pancreatic disease and also of other diseases.

The most important symptom is the presence of a tumor in the region of the pancreas. This can be made out in only a few cases because the pancreas is so surrounded by liver, stomach, and

intestine that it can rarely be felt in persons with rigid or fat abdominal walls. If a tumor can be made out, it is easy to determine whether it lies behind the stomach and colon by distending these organs with air.

If a swelling in the region of the pancreas can be demonstrated in a patient who is losing weight, and suffers from jaundice and colicky pain for which no explanation can be found in the gall-bladder, stomach, or intestine, the probable diagnosis is pancreatic disease.

Diseases of the stomach and intestine, and especially diseases of the biliary tract, are often starting-points for disease of the pancreas. In not a few instances injury in the epigastric region has led to pancreatic disease. The interest of the surgeon is centred in the various injuries, inflammations, tumors, and concretions of which the pancreas may be the seat.

CHAPTER XXVIII.

INJURIES OF THE PANCREAS.

Situated as is the pancreas, at the back of the abdominal cavity, partly covered by ribs, liver, stomach, and colon, it is well protected from injury. If a patient is run over or crushed between cars, the force must be sufficient to overcome the elasticity of the ribs before the pancreas suffers. A blow directed upward—for example, the kick of a horse—may produce an injury of the pancreas.

As the pancreas is covered by other organs (stomach, liver, intestine, and spleen), it is rarely injured alone, and the existing injury of one of these other organs makes the prognosis more grave.

Examinations upon the cadaver show that in certain conditions, especially in gastroptosis and coloptosis, a part of the pancreas is covered only by the abdominal walls and reduplicatures of the peritoneum. Under such circumstances it may be injured by direct violence—for example, in stab-wounds—although other organs are uninjured.

SUBCUTANEOUS INJURIES OF THE PANCREAS.

The three chief causes of subcutaneous injury of the pancreas are the passage of a wagon-wheel across the abdomen, a crush between car-buffers, and the kick of a horse. If the injury is slight, the blood escapes into the tissues of the organ and beneath the peritoneum which covers it. Such an effusion of blood may form a pancreatic or peripancreatic cyst. Injury of the organ may lead to inflammation, suppuration, or necrosis.

If the force of the injury is great, the pancreas may be crushed against the vertebral column and partially or wholly divided. In one such case Mikulicz opened the abdomen and evacuated the blood. Five months later the patient died of pneumonia, and at autopsy a complete transverse scar showed how the injury had divided the pancreas.

Injury of the pancreas cannot be known with certainty until the abdomen is opened, as the patient complains merely of the symptoms of abdominal injury. Shock is well marked and the abdominal muscles are rigid. In every case of severe contusion of the pancreatic region the surgeon should think of possible injury of the pancreas, and if there are signs of swelling or hemorrhage in its vicinity the organ should be exposed by opening the lesser cavity of the peritoneum, or through the transverse mesocolon. If the wound in the

pancreas is peritoneal simply, it may be sutured, otherwise it should be tamponed with gauze.

OPEN WOUNDS OF THE PANCREAS.

Gunshot- and stab-wounds of the pancreas are rare accidents, and for the reasons stated above injury to the pancreas is usually complicated by injury to the surrounding organs. A careful search through European medical literature since 1898 revealed the reports of 8 cases of direct wound of the pancreas, 4 of which were recovered from. All of these patients were treated by laparotomy. In 1 case the wounds were sutured, but the usual treatment was by tamponade. These cases show that in gunshot-wounds of the epigastric region the pancreas should always be examined. Küttner mentions a case of stab-wound of the pancreas in which immediate laparotomy and suture succeeded in saving the patient, although the stomach also was wounded.

If the abdominal wound is large, the tail of the pancreas may prolapse; the head of the organ is so fixed behind the duodenum as to be practically immovable. If such a patient is seen soon after the accident, and the organ appears clean and uninjured, it may be sponged and restored to its normal position. If there is any doubt as to its circulatory condition, it should be ligated and excised and the wounded surface reduced to a minimum by suture.

CHANGES IN POSITION OF THE PANCREAS.

The head of the pancreas is so firmly adherent to the movable duodenum that changes in its position are practically unknown. The tail of the organ is attached to the spleen, and it may be displaced with the spleen. In rare cases the pancreas has been found in the sac of a congenital or acquired umbilical hernia, or in a diaphragmatic hernia.

CHAPTER XXIX.

DISEASES OF THE PANCREAS.

HEMORRHAGE IN THE PANCREAS AND ITS VICINITY.

Spontaneous hemorrhage may occur in the pancreatic tissue, producing distention of the organ and sudden death. This accident occurs chiefly among stout individuals and takes place suddenly without warning, so that a person apparently in perfect health is seized by an attack of intense epigastric pain with nausea and vomiting, followed by rapidly increasing collapse and death. The cause of such hemorrhage is not fully understood, for in certain cases the pancreas appears perfectly normal; in other cases, however, fatty degeneration of the gland or disseminated fat-necrosis, or degeneration of the vessel-walls exists before the attack of hemorrhage.

Slighter hemorrhages may also occur in the pancreas in connection with general circulatory disturbances. Hemorrhage from traumatism was spoken of in the preceding chapter.

The diagnosis of pancreatic apoplexy cannot be made with much certainty, and on account of the rapid course of the affection treatment has thus far proved useless. Operation and control of the hemorrhage by gauze packing are rendered difficult or impossible by reason of the intense collapse.

There are a few cases in which hemorrhage has ceased spontaneously after the first attack and a blood-cyst has formed in the pancreas. Rasunowski operated successfully several weeks after such an acute attack.

The patient may recover from the hemorrhage and suffer from the destruction of pancreatic tissue which is secondary to it. Operation may then be required on account of the pancreatic necrosis. This idiopathic hemorrhage should be carefully distinguished from the hemorrhage occurring in an inflammation of the pancreas, or acute hemorrhagic pancreatitis, as it is called. (See page 722.)

INFLAMMATIONS OF THE PANCREAS.

Inflammations of the pancreas have recently excited a great deal of surgical interest and many cases have been reported. It is quite likely that slighter forms of inflammation frequently accompany affections of the mucous membrane of the upper portion of the alimentary canal or of the biliary passages, but these milder forms escape notice.

The severe forms of inflammation leading to suppuration, necrosis, or induration often require surgical treatment.

The pancreas may become acutely inflamed from the blood in such infectious diseases as smallpox, puerperal fever, and typhoid, as well as in pyelophlebitis. The inflammation in such cases is a part of the general pyæmic process, and is therefore scarcely amenable to surgical treatment.

The gland may become inflamed from the intestine or common bile-duct if micro-organisms find their way into the pancreatic duct. Furthermore, ulcerative processes of the stomach and duodenum may permit the entrance into the pancreas of germs of inflammation. A calculus near the pancreatic duct may be the predisposing cause of inflammation. In such circumstances micro-organisms may either pass up the pancreatic duct, setting up suppuration which extends to its minute branches, or they may pass through the wall of the pancreatic duct and spread in the intralobular and periacinous tissue. (Dieckhoff.)

Inflammation has been set up experimentally by the injection of irritating substances and of bacteria. There may follow, according to the degree of irritation or to the virulence of the bacteria, sclerosing or suppurating or hemorrhagic or necrosing inflammation.

The occurrence of pancreatitis in connection with cholelithiasis, and especially in connection with a calculus of the common duct, has been repeatedly observed. Halsted cites a most instructive case. He operated for acute hemorrhagic pancreatitis but failed to save the collapsed patient. At autopsy Opie found a small calculus which closed the papilla of the duodenum. Bile had already made its way into the pancreatic duct. The injection of 5 c.c. (77 grains) of the bile from this patient into the pancreatic duct of a dog brought about an acute hemorrhagic inflammation.

In men injury of the pancreas and spontaneous hemorrhage are predisposing factors for inflammation, since the destruction of the gland-tissue forms a favorable soil for infection extending to it from the intestine.

Chiari and Pförringer speak of self-digestive processes in the pancreas. It is possible that they play a part in connection with inflammation and trauma.

DISSEMINATED FAT-NECROSIS.

Ponfick and others have called attention to the disseminated necrosis of fatty tissue which often accompanies traumatism, inflammation, or necrosis of the pancreas. In such circumstances there exist in the fat-tissue around the pancreas, behind the peritoneum, in the mesentery and omentum, numerous yellow spots varying in size from that of a flaxseed to that of a pea, which if examined microscopically show the necrotic changes of fatty tissue. The fat-cells break up, the fluid portions are resorbed, and the solid portions (fatty acids) unite with calcium to form fatty acid lime salts. (Langerhans.) This fat-

necrosis is most frequently seen in connection with hemorrhagic pancreatitis, gangrene and injury of the pancreas, and less often in connection with suppurative inflammation. Observers disagree on the question whether the fat-necrosis is the primary change or whether it is secondary to changes in the pancreas. Those who hold to the latter theory believe that the changes in the fatty tissue may be due to pancreatic juice which escapes from the injured or inflamed gland. Similar changes can be produced in animals by the action of the pancreatic juice.

On the other hand, it is to be noted that disseminated fat-necrosis is occasionally found at autopsy in persons whose pancreas seems perfectly healthy, so that it is conceivable that pre-existing fat-necrosis of the pancreas or in its vicinity favors the occurrence of hemorrhage or inflammation.

Fitz, who first studied inflammations of the pancreas extensively, divided them into suppurative, acute hemorrhagic, and necrotic. This classification serves for practical purposes, although cases are found which present combinations of these three forms of inflammation.

SUPPURATIVE PANCREATITIS

Inflammation of a suppurative character is usually due to the entrance of germs from the intestine or biliary tract. A diffuse suppurative infiltration of the gland results which often leads to secondary necrosis of a considerable portion of the organ. Sometimes a number of disconnected abscesses are formed, or there may be a single large abscess cavity. The pus breaks its way into the peripancreatic tissue and often perforates into the lesser peritoneal cavity; or it may work its way retroperitoneally and around in the loin; or it may burst above the lesser curvature of the stomach into the left subphrenic space. The abscess may also rupture into the stomach or intestine. Suppurative thrombi may form in the branches of the portal vein and lead to abscesses in the liver and spleen. Rupture externally rarely occurs. The process may go on extraperitoneally, but usually there will be set up a circumscribed or diffuse peritonitis. Various micro-organisms (pus cocci, diplococci, bacterium coli) have been found in the pus from these abscesses.

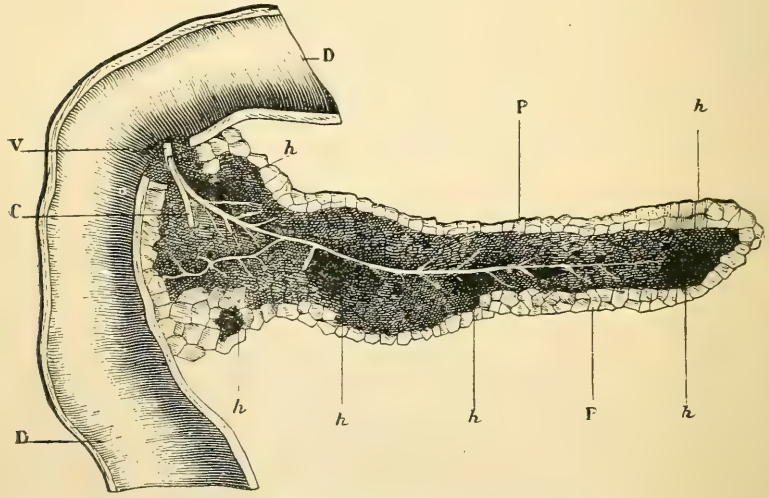
Some cases of suppurative pancreatitis begin acutely with pain in the epigastrium, nausea, vomiting, disturbances of digestion; or they may begin with chills and fever. In other cases the disease begins gradually with repeated attacks of pain and gastric disturbances. Attacks of biliary colic often precede the pancreatitis.

Suppurative pancreatitis in general is less acute than the hemorrhagic form. It is characterized by a circumscribed inflammation in the epigastrium which in many cases makes a distinct inflammatory tumor which can be recognized by palpation. It is seldom accompanied by glycosuria, although this symptom may develop as the disease progresses.

HEMORRHAGIC PANCREATITIS.

The second form of acute inflammation of the pancreas is associated with hemorrhages into the substance of the gland and leads to necrosis of portions or the whole of the pancreas. The onset of the trouble is usually most violent. The patient is suddenly taken with intense continuous or recurring epigastric pain, so that consciousness is often lost. There are nausea, vomiting, and cessation of peristaltic action. The abdomen is distended, especially in its upper portion; the pulse is small and rapid. There may be no fever whatever. This disease has frequently been mistaken for intestinal obstruction or perforative peritonitis. Its most marked symptom is the increasing collapse.

FIG. 335.



Hemorrhagic pancreatitis: *D*, duodenum; *P*, pancreas; *V*, canal of Wirsung; *C*, common duct; *h.h.*, hemorrhagic areas. (Laboulbène.)

Operation has several times been performed in this acute stage of the disease, usually with fatal result. Several surgeons have, however, saved their patients by opening the peritoneal cavity and allowing the bloody or serous exudate to escape. If the patient dies in this acute stage of the affection, his pancreas will be found swollen and saturated with blood, while the cut section presents an appearance of marble. (Fig. 335.) The peritoneum is intensely reddened and the peritoneal cavity contains more or less bloody serum. Disseminated fat-necrosis frequently coexists. There may be desquamative inflammation of the pancreatic duct, and there are often thrombi in the surrounding veins. Microscopical examination of the pancreas shows hemorrhages in its tissue, intense infiltration with leucocytes, and commencing necrosis in the portions most affected. Cholelithiasis often coexists.

The diagnosis in this acute stage can only be a probable one, and there is little encouragement for operating on account of the strong tendency to collapse. If operation is performed, it should be done as quickly and simply as possible. Although there are symptoms of intestinal obstruction, no mechanical obstruction has yet been made out. The cessation of peristaltic action is probably due to a spreading peritonitis, or to an intense irritation of the nerve-centres of the solar plexus.

If the patient survives the first stage of the disease, partial or total necrosis of the organ results. The same effect may be caused by non-inflammatory spontaneous or traumatic hemorrhage into the gland or in its vicinity. The necrosis itself causes intense symptoms which often lead to collapse and death; but sometimes the acute stage passes into a chronic one with gangrene of the affected portion of the gland.

NECROSIS OF THE PANCREAS.

Pancreatic necrosis, whether it results from inflammation, or hemorrhage, or traumatism, gives rise to fairly characteristic symptoms and is amenable to surgical treatment.

The affected portion of the gland becomes separated from the living portion by a reactive inflammation. This inflammation is usually due to the bacteria which caused the original inflammation; or the germs may be introduced later from the intestine into the necrotic tissue. The necrotic focus is situated behind the peritoneum; and even though the peritoneum be not involved, there is a tendency to further extension of the affection, as is the case in pancreatic abscess. This extension may take place in the various directions mentioned under the head of pancreatic abscess, and which can be demonstrated by injections of coloring-matter in the cadaver. The process may break through the peritoneum into the lesser peritoneal cavity, or it may extend retroperitoneally to the right, especially if the head of the pancreas is affected, or to the left if the tail is the seat of necrosis, working its way in either case behind the colon to appear below the kidney in the loin. This gangrenous cavity, which contains the necrotic gland, may remain encapsulated; or it may rupture into the peritoneal cavity or into the intestine. In the latter case the necrotic pancreas may be discharged through the rectum. The neighboring veins are exposed to the risk of infection with subsequent abscess of the liver or spleen. In rare instances necrosis goes on without suppuration.

The symptoms of this stage of necrosis are those of a circumscribed inflammation in the upper portion of the abdomen. They are not so violent as those of the first stage. Fever is usually of an intermittent type. Gastric and intestinal digestion is affected, and the patient loses flesh and strength. The urine does not contain sugar unless it did so previous to the pancreatic attack (diabetes). The skin often becomes dry and has a grayish-brown coloration.

The diagnosis rests upon the sequence of symptoms described above and the existence of an inflammatory tumor in the upper abdomen. The latter is the chief point in diagnosis. This tumor can be shown to lie behind the stomach and colon by distention of these organs with air. In this manner empyema of the lesser peritoneal cavity can be recognized. It should be borne in mind that ulcerative processes in a stomach or duodenum (simple ulcer or carcinoma) may lead to suppuration in the same space.

SURGICAL TREATMENT OF SUPPURATION AND NECROSIS OF THE PANCREAS.

The object of surgical treatment in suppuration within or in the neighborhood of the pancreas is to open and drain the abscess cavity. If this is done before general peritonitis or suppurative thrombosis or hepatic and splenic abscesses have complicated the pancreatic condition, recovery may follow.

The operation varies according to the seat of the suppuration. If the pus is in the lesser cavity of the peritoneum, an incision should be made in the linea alba and then through the gastrocolic omentum. The gastrocolic omentum is surrounded by gauze and incised between ligatures or torn through. The pus cavity may be wiped clean or irrigated with saline solution, and drained with large tubes surrounded by gauze. If the cavity extends clear to the left, a counteropening for drainage should be made in the loin. Cases in which the cavity is best drained above the stomach or below the transverse colon are rare. If cholelithiasis and pancreatic abscess coexist, the abscess may be opened from the right side of the jejunum. This complication of cholelithiasis is sufficiently common to make it advisable to examine the head of the pancreas in every case in which a calculus is situated in the common duct. If the pus at the time of operation has already made its way along the colon to the lumbar region, incision and drainage should be made in that situation.

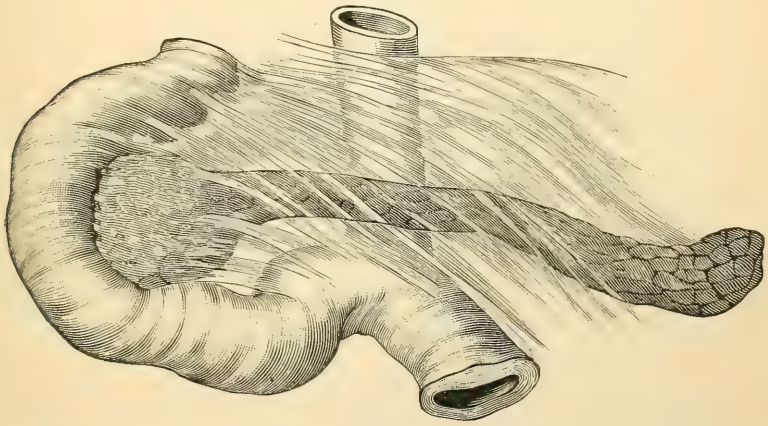
When the abscess cavity is opened, the pus and gangrenous material and necrotic portions of the pancreas forthwith make their escape. Such a patient is exposed to the risk of secondary hemorrhage from large eroded vessels, and to that of purulent thrombosis or embolism. If he recovers, there usually exists a pancreatic fistula in the site of the incision which may ultimately close spontaneously. One case is recorded in which a patient who recovered from operation suffered from symptoms of diabetes one and a half years afterward, from which he died seven years after operation. At autopsy only the head of the pancreas was found, the site of the body and tail being occupied by scar-tissue. There is doubt whether the diabetes in this case was due to the loss of a part of the pancreas. There are other cases in which sugar was found in the urine either at or immediately after operation, and in which this condition must be looked upon as the cause rather than the effect of the pancreatic abscess.

In recent literature there are numerous reports of successful operations for pancreatic suppuration either with or without necrosis. At least 18 such cures were reported up to the year 1901.

CHRONIC INTERSTITIAL PANCREATITIS.

There is an inflammation of the pancreas in which new-formed connective tissue surrounds the lobules of the gland and extends around the vessels and ducts and penetrates between the acini. The parenchymatous tissue atrophies and is replaced by connective tissue and fat. This process occurs especially in the head of the gland, where it can easily cause symptoms by pressure upon the common bile-duct or upon the duodenum. The affected portions of the gland are swollen, hard, and nodular. Incision into this tissue shows it to be abnormally firm. The inflammation frequently leads to the development of numerous small

FIG. 336.



Sclerosis and atrophy of pancreas following partial obstruction of the canal of Wirsung.

cysts. This interstitial inflammation may be due to infection from the bile-ducts, duodenum, or stomach (the ascending method of Dieckhoff); or it may be due to pancreatic lithiasis, or to an obstruction of the pancreatic duct by scar-tissue or a tumor (Fig. 336); or it may be due to traumatism. Finally, its origin may be hæmatogenous (syphilis, arteriosclerosis, alcoholism).

Chronic pancreatitis has been caused in animals by contusion of the gland, by obstruction of its duct, and by the injection of irritating chemical or bacteriological material.

The clinical symptoms of interstitial pancreatitis are rather indefinite. They are gastric disturbances, constipation or diarrhœa, dull pain in the epigastrium, sometimes with periodic exacerbations, emaciation, loss of strength, and in certain cases jaundice and symptoms of duodenal obstruction. None of these symptoms is by itself sufficient for a diagnosis of this disease. The head of the swollen gland can some-

times be felt as a hard, tender tumor in an emaciated patient whose ribs are not too long. But even under such circumstances the differential diagnosis from carcinoma is scarcely possible. The course of the trouble is usually very chronic. It may cost the life of the patient by disturbances of nutrition or by pressure upon the common duct, duodenum, or portal vein.

The experience gained by exploratory laparotomies and by operations upon patients in whom cholelithiasis and pancreatitis coexist have shown that chronic inflammation of the head of the pancreas may disappear if biliary obstruction or duodenal stenosis is relieved. Obstruction of bile due to calculus in the common duct does not ordinarily distend the gall-bladder. Obstruction due to interstitial pancreatitis usually distends the gall-bladder. The characteristic attacks of biliary colic are not apt to occur unless there are calculi. If the patient suffers at the same time from interstitial pancreatitis and calculi, a diagnosis is extremely difficult. The disappearance of swelling of the pancreas when biliary obstruction is overcome is supposed to be due to removal of the irritation set up by the presence of a calculus, or an accompanying inflammatory process.

Operation consists in the removal of calculi and inflammatory products from the gall-bladder and ducts, together with subsequent drainage. If no calculus is found, but a distention of the biliary passages, colostomy or cholecystenterostomy is indicated. The first operation is followed by a biliary fistula which may close spontaneously if the pancreatic swelling decreases sufficiently to relieve the pressure on the common duct. Anastomosis between the gall-bladder or ducts and the small intestine saves the patient from a biliary fistula, but it is a difficult operation, and there is a certain risk that intestinal bacteria will enter the biliary ducts and set up cholangitis. By palpation alone it is scarcely possible to distinguish carcinoma of the head of the pancreas from interstitial pancreatitis even after the abdomen has been opened.

CYSTS OF THE PANCREAS.

Pathological Anatomy.—Since Gussenbauer, in 1882, first called attention to the correct diagnosis and treatment of pancreatic cysts a great many operations for this condition have been recorded. Körte collected 177 up to the beginning of 1902.

The origin of pancreatic cysts has been carefully studied by Dieckhoff, Tilger, and Lazarus. They classify them into:

1. Retention-cysts of the pancreatic duct.
2. Proliferation-cysts, or cystadenomata.
3. Retention-cysts due to obstruction of the minor branches of the pancreatic duct the result of interstitial pancreatitis. The inflammation may be of traumatic origin or it may be an ascending inflammation from the intestine.
4. Cysts that develop by softening in tumors (carcinoma), by the

digestion of encapsulated hemorrhage, and by the degeneration of a part of the pancreas in acute pancreatitis.

5. An inflammatory or traumatic exudate may rupture into the lesser peritoneal cavity and so simulate a cyst of the pancreas. Such a false pancreatic cyst has also been observed after necrosis of the pancreas without gangrene.

Retention-cysts due to obstruction of the pancreatic duct have been observed for the most part only at autopsy. The other forms of cysts mentioned are met with at operation. As in most instances the cyst has been sutured in the abdominal wound and drained, its exact nature has not been determined; but there are many facts which go to show that true cysts of the pancreas frequently develop. Such a cyst is at first lined with epithelium, but these cells are often digested away in the course of time, so that they will not be found at the time of operation. The complete cure which follows the drainage of such a cyst is to be attributed to this fact. If the epithelial cells persisted, obliteration of the cavity of the cyst would be impossible. Many of these cysts contain more or less blood which has escaped from erosions in the cyst-wall due to the digestive action of the contents of the cyst.

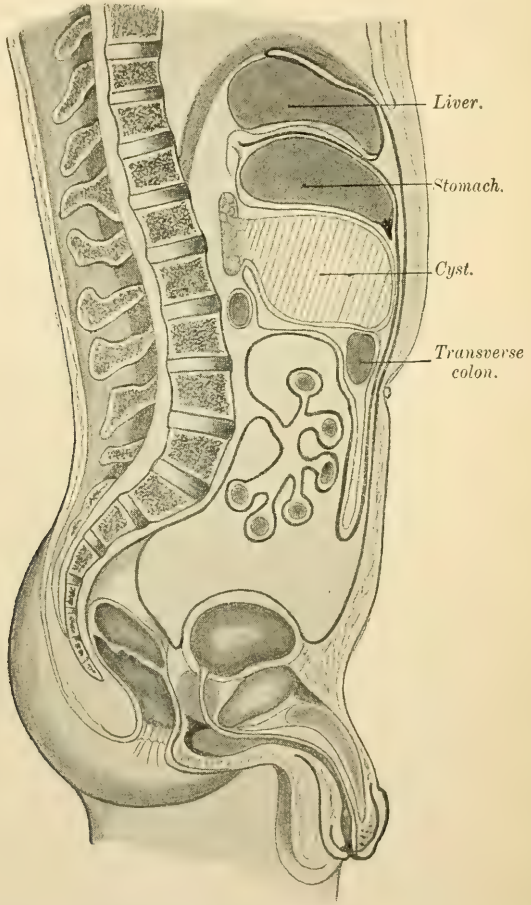
FIG. 337.

Pancreatic cyst. (Warren Museum.)

The cysts which follow a traumatism of the upper portion of the abdomen have been ascribed by some writers to hemorrhage into the lesser cavity of the peritoneum; but experiments upon animals show that a hemorrhage into the pancreas will not be absorbed, but will give rise to cystic formation if the conditions are unfavorable for resorption (application of tincture of iodine to the injured parts). Thus there seems little doubt that true pancreatic cysts may follow hemorrhage into the human pancreas. On the other hand, some of the cysts which develop from hemorrhage into the gland or in its vicinity are so-called false pancreatic cysts and are situated in the lesser cavity of the peritoneum. In some of these cases the injury of the pancreas leads to a discharge of pancreatic secretion into the false cyst, so that its contents at the time of operation may have digestive powers, and a pancreatic fistula may even follow operation.

A lymph-cyst may develop in the vicinity of the pancreas although it has nothing whatever to do with this organ. Indeed, in some cases it is extremely difficult to determine the origin of a cyst unless at operation or at autopsy one is able to make a careful examination of the relations between the cyst and the pancreas. The presence of pancreatic ferments in the contents of a cyst, or in the secretion following drainage of a cyst, makes it clear that the cyst originated in the pancreas.

Fig. 338.



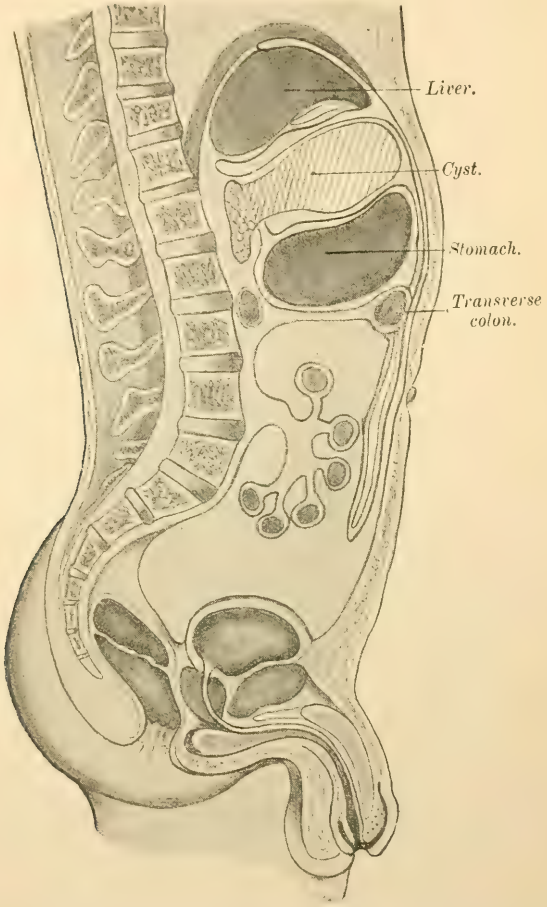
Cyst of the pancreas developing between the stomach and transverse colon. The gastrocolic omentum lies in front of the cyst.

Echinococcus cysts of the pancreas have been mentioned, but they occur with great rarity.

Symptoms.—Pancreatic cysts are usually seen during middle life, although they may occur at any age. Both sexes are equally affected. A pancreatic cyst usually develops slowly and does not attract attention

until it begins to press on the neighboring organs; but in about one-fourth of the cases it clearly follows a traumatism of the upper portion of the abdomen. The interval between the traumatism and the time when the cyst is first noticed varies between a few weeks and several years. If a cyst develops in a few weeks after injury, the fluid will usually be found in the lesser cavity of the peritoneum (false cyst).

FIG. 339.



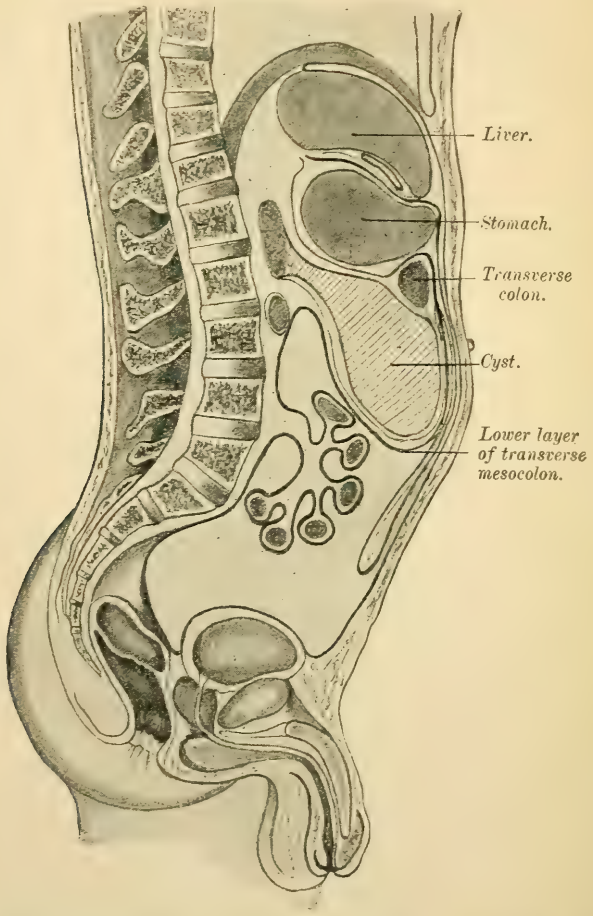
Cyst of the pancreas developing between the stomach and liver. The lesser omentum, and possibly the foramen of Winslow, is crowded forward by the cyst.

The patients in whom a cyst is not noticed until many months after traumatism have generally suffered in the meantime from attacks of pain, etc., in the upper abdomen. Other cysts not due to traumatism are preceded by a series of inflammatory symptoms, gastric disturbance, and colicky pain.

Most of the symptoms complained of in case of pancreatic cyst are

due to pressure upon the stomach. The pain, nausea, and vomiting may be so severe that intestinal obstruction is suggested. There are marked emaciation and loss of strength. If the bile is prevented from reaching the intestine, there will be jaundice. There are no certain specific symptoms due to interference with the pancreas itself. Such a cyst may become very large and by its mere bulk interfere with the

FIG. 340.



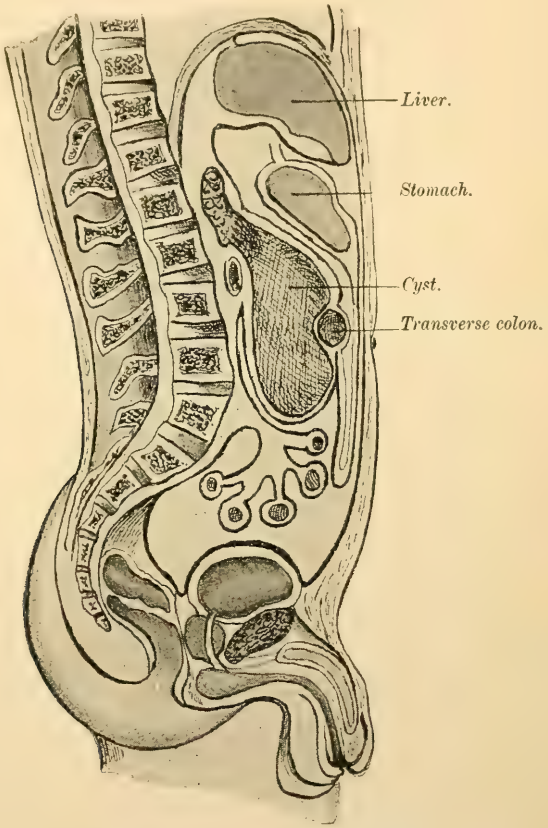
Cyst of the pancreas developing between the layers of the transverse mesocolon and stretching the lower layer more than the upper.

functions of the neighboring organs. (Fig. 337.) The cœliac plexus is situated close to the pancreas, and some of the pain experienced is supposed to be due to pressure upon it. Only in rare instances is the symptom pain wanting.

As a rule the cyst presents itself as a spherical or half-spherical

projection with tense walls. Its outline is sometimes best shown when the patient stands. It may be of any size. Instances are recorded of cysts containing 15 or 20 litres (quarts) of fluid. The cyst possesses a limited amount of motion, whereas the pancreas is firmly fixed to the posterior wall of the abdomen. If it develops in the tail of the organ or possesses its own pedicle, its mobility is greater. There are a few instances in which such a cyst suddenly disappears (presumably to rupture into the intestine) and then reappears.

FIG. 341.



Cyst of the pancreas developing between the layers of the transverse mesocolon. The colon lies directly in front of the cyst.

A cyst of the pancreas may occupy one of several positions:

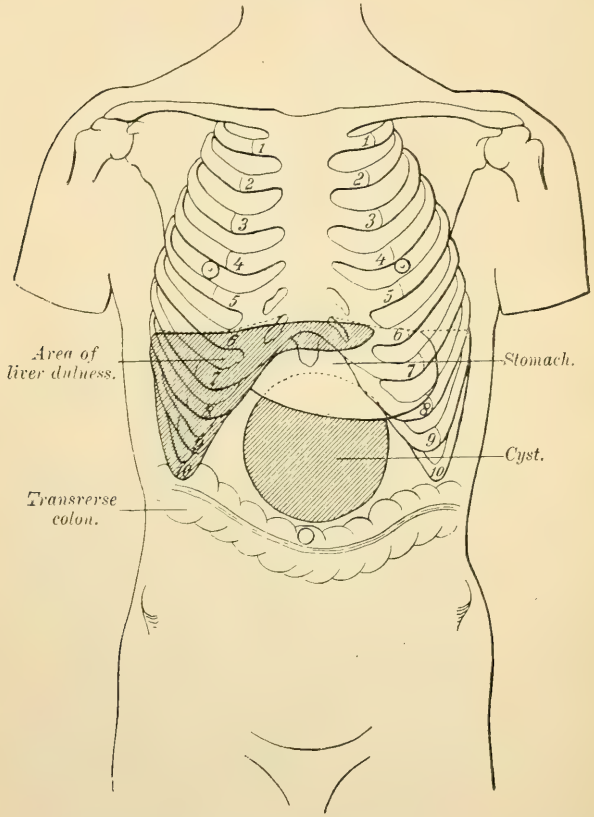
A. As a usual thing it develops in the lesser peritoneal cavity between the stomach and transverse colon. In this case it presses forward the gastrocolic ligament. (Fig. 338.)

B. Less often the cyst lies above the stomach, pushing in front of it the gastrohepatic ligament and crowding forward between the liver and the stomach. Twelve cases of this sort are on record, in one of

which, mentioned by Albert and Payr, the cyst projected through the foramen of Winslow. (Fig. 339).

C. The cyst may develop between the layers of the mesocolon, in which case the transverse colon may lie in front of the tumor, or somewhat above it. (Figs. 340 and 341.)

Fig. 342.

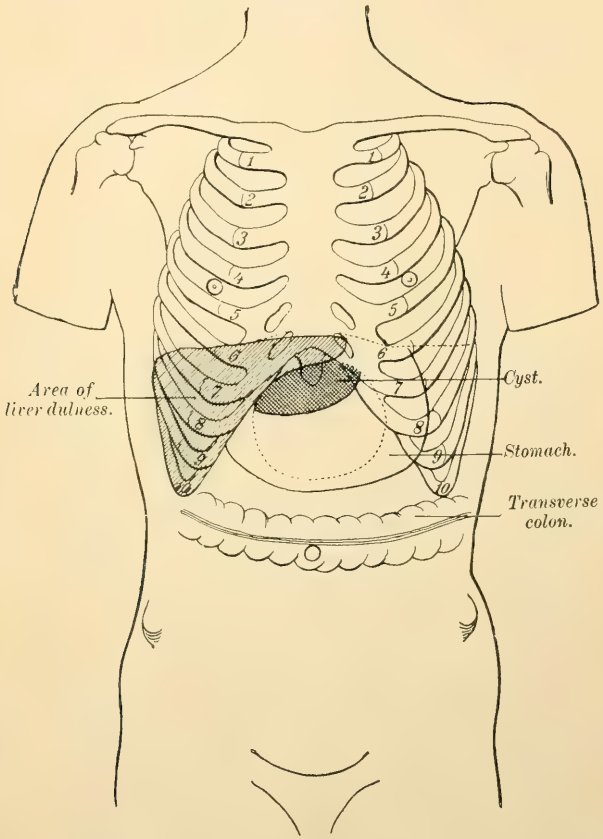


Showing the relations of the liver and transverse colon to the tumor caused by a typical pancreatic cyst. The stomach is displaced upward and partially overlaps the cyst. The transverse colon follows its lower margin.

The contents of a pancreatic cyst is an alkaline fluid containing albumin, and with a specific gravity of 1.010–1.020, though in some cases it may be either higher or lower than these figures. Sometimes the fluid is as clear as water, sometimes it is slightly or deeply stained with blood. It frequently contains one or more of the pancreatic ferments. If such is the case, diagnosis is certain, but their absence does not prove that the cyst is not of pancreatic origin, for they are frequently absent in old cysts, but they may reappear in the discharges after the cyst is drained.

Diagnosis.—The diagnosis of a pancreatic cyst rests in the first place upon the history (previous traumatism or inflammation), upon the presence of symptoms due to pressure, and, further, upon the relations of the stomach and transverse colon to a tumor, as shown when these organs are distended with air. Thus, in type A mentioned above, when the stomach and colon are distended they will be found on opposite sides of the cyst. This is the typical relation which exists when the cyst is in the lesser peritoneal cavity. (Fig. 342.)

FIG. 343.



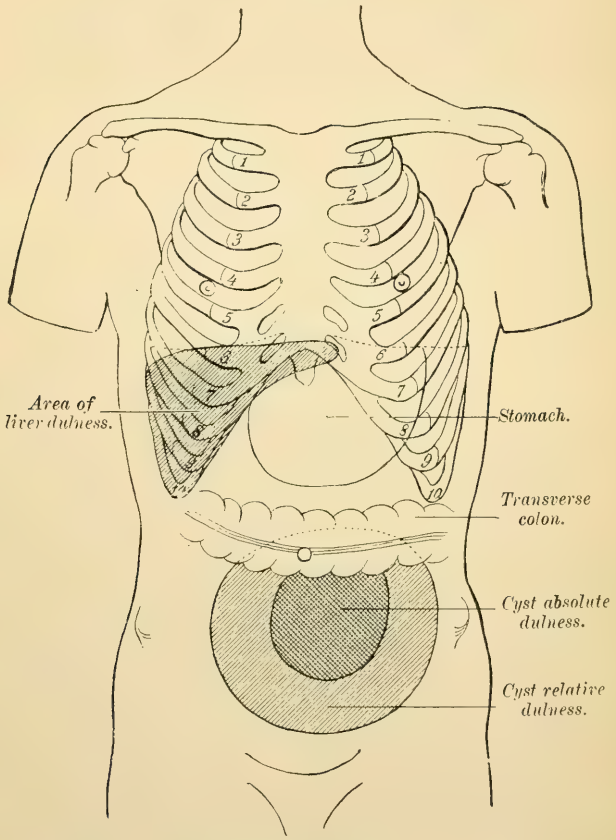
Showing the relations of the liver, stomach, and transverse colon to a cyst of the pancreas, type B. The stomach lies in front of and below the cyst.

In type B the cyst is crowded in between the stomach and the liver, and the stomach and transverse colon are nearly or quite in contact. (Fig. 343.)

In type C the colon when distended either rotates upon the cyst or is situated somewhat above it, so that the cyst cannot be differentiated from the cyst of the mesentery. (Fig. 344.)

In many cases one can do no more than to make a diagnosis of retroperitoneal cyst, unless some of the contents of the cyst are aspirated for chemical analysis. Such aspiration is inadvisable, as it may be followed by the escape of cyst contents into the abdomen and the development of serious or even fatal peritonitis. Furthermore, when the fluid is obtained, a positive diagnosis can only be made in case it contains ferments, and these are often wanting, even in the contents

FIG. 344.



Showing the relations of the liver, stomach, and transverse colon to a pancreatic cyst of type C. The transverse colon lies in front of the cyst or along its upper border.

of a pancreatic cyst. Finally, a differential diagnosis between retroperitoneal cysts is unnecessary. It is sufficient for the purpose of operation to know that there is a retroperitoneal cyst situated behind the stomach and transverse colon.

If the tumor is of type A, a diagnosis of pancreatic cyst can be made with considerable degree of probability. If the tumor is of type B, one must bear in mind the possibility of echinococcus cyst growing

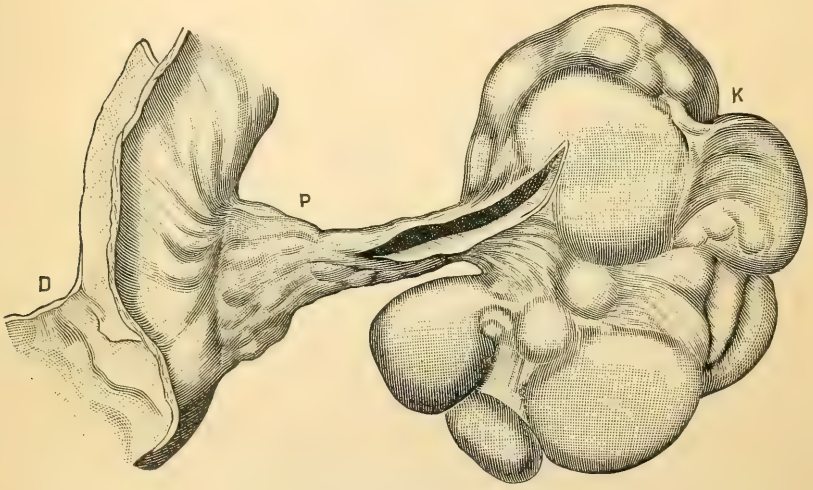
from the lower surface of the liver. If the tumor is not in the median line, cysts of the kidney and suprarenal body must be considered. If a puncture can be made from the loin, the procedure is permissible provided it is to be followed immediately by operation.

A cyst of the mesocolon has exactly the relations of a pancreatic cyst of type C. The operation for its removal is the same. Other conditions to be considered in differential diagnosis are cysts of the omentum, or of the posterior wall of the stomach, or of the retroperitoneal lymph-vessels, or of the remains of the Wolffian ducts.

Cysts of the pancreas cause serious symptoms, interfere materially with digestion, and expose the patient to the risk of rupture with fatal result; therefore operative treatment is clearly indicated.

Treatment.—Puncture of a pancreatic cyst has rarely led to a cure. In most cases the fluid reaccumulates. It may trickle into the

FIG. 345.



Cystic adenoma (*K*) of the left half of the pancreas (*P*); *D*, duodenum. (Lancereaux.)

abdominal cavity and set up serious inflammation. For these reasons puncture is not to be recommended. In case it is performed the facilities for an immediate laparotomy ought to be at hand.

In most cases of pancreatic cyst suture of the cyst-wall into the abdominal wound with drainage is the typical method of treatment. Extirpation is indicated in only a minority of cases.

An incision is made over the crest of the tumor. When the abdominal cavity is opened, the surgeon determines by examination at what point the cyst is most accessible. It lies usually behind the gastrocolic omentum, less often behind the gastrohepatic omentum, or below the transverse colon. In the last situation it is covered by the omentum and the lower layer of the transverse mesocolon. The reduplication of peritoneum which covers the cyst, whatever its origin, is torn through or divided between ligatures of its vessels, and the

wall of the cyst is exposed. If the cyst is movable, this extirpation may be possible. If its layers are adherent, as is usually the case, it must be treated by a suture to the cut edges of the injured peritoneum. The peritoneal cavity should be protected during this suture, as the wall of the cyst is often thin and easily torn. The needles used should be small and round. If a fairly good suture is possible, the cyst should be at once incised, irrigated with saline solution after its contents have escaped, and sponged out with gauze, so that any necrotic portions of the pancreas may be removed. It is then drained with a rubber tube surrounded with gauze. The edges of the abdominal wound are partially sutured and protected from the eroding influence of the secretion by a zinc oxide salve. If the cyst is situated far to one side, a counterdrain may be inserted through the loin. If the wall of the cyst is full of bloodvessels, or for any other reason it cannot be sutured to the parietal peritoneum, the wound should be tamponed with gauze and incision of the cyst postponed until adhesions have formed.

As a rule the large cavity shrinks rapidly and granulations spring from its walls. Sometimes the inner lining of the cavity sloughs out. A fistula often remains and discharges pancreatic juice in varying quantities up to 1000 c.c. a day. This discharge, if allowed to come in contact with the skin, may produce digestive ulcers. Such a fistula may persist for years, or it may heal spontaneously or after it has been injected with astringents such as tincture of iodine, zinc chloride, or silver nitrate; or after cauterization, curettage, or excision. In one case it is mentioned that a fistula which had existed a year and a half eroded the splenic artery, producing a fatal hemorrhage.

In rare instances the fistula closes and the cyst re-forms.

Suture of a pancreatic cyst in the abdominal wound with drainage is not a dangerous operation. In a series of 141 cases 7 patients died immediately after the operation, and 1 at a later date from infection developing in the fistula. The chief risk of the operation is from the escape of cystic contents into the peritoneal cavity, with resulting peritonitis.

In only a few cases is extirpation of the cyst possible or advisable. This operation should not be attempted unless the cyst-wall is practically free from adhesions to the surrounding organs. It is easy if the tumor has a sort of pedicle, which is apt to be the case with a cyst of the tail of the pancreas. In performing the operation the cyst is first exposed and its relations determined. Unless these are satisfactory, the idea of extirpation should be given up, for 4 of 9 patients in whom a difficult extirpation was attempted died. Even in favorable cases extirpation may prove difficult. The wall of the cyst is freed little by little, injury to the stomach and intestine and large vessels being avoided. Ligation of the vessels of the mesocolon is apt to be followed by gangrene of the bowel. The splenic artery may be ligated without injurious result. Dissection of a cyst from the pancreas is followed by a considerable hemorrhage which must be carefully controlled. If

there is a pedicle, this is more easily ligated and divided. Zweifel removed with a cyst so much of the pancreas that only the head remained. Temporary glycosuria was the result. The retroperitoneal wound which remains after the removal of the cyst should be covered by a suture of the posterior peritoneum; or, if there is still some bleeding, gauze drainage is preferable, perhaps through the loin. There are recorded 22 cases of extirpation of pancreatic cyst, with 4 deaths. In 1 of these fatal cases peritonitis existed at the time of operation, and portions of the transverse colon and stomach were excised with the tumor, which proved to be cystosarcoma.

SOLID TUMORS OF THE PANCREAS.

Carcinoma is the commonest solid tumor of the pancreas, and its type is usually scirrhous, less often adenocarcinoma, while gelatinous and giant-cell forms are still more rare. Adenoma, sarcoma, and lymphoma are other rare tumors which occasionally occur. Tuberculosis is seldom found. Syphilis may exist in the form of gumma or as a chronic interstitial inflammation.

It is impossible to differentiate clinically between primary carcinoma and sarcoma of the pancreas. These tumors occur usually in middle life, though they may develop at a very early age. At first they cause few symptoms; later there are a peculiar pain in the epigastrium, rapidly increasing cachexia, and then a palpable tumor. In the early stages such characteristic symptoms as fatty stools and glycosuria are wholly wanting, and even in the later stages they are not always present. Contraction of the common duct is a late complication. In view of these facts an early diagnosis is most improbable. The presence of a palpable tumor is the chief point of diagnosis, and its relations to the stomach and intestine can be made out in accordance with the rules given in the preceding section.

Experiments upon animals seem to show that the removal of the entire pancreas carries with it the risk of diabetes, but the subject needs further study. Franke removed the whole pancreas from a woman on account of carcinoma. The patient lived five and a half months, during which time the stools were normal, and the operation was followed by only a temporary glycosuria. Tricomi removed for carcinoma all of the pancreas except a small portion of the tail. His patient suffered from no symptoms which could be attributed to the loss of the gland, and died four months later from metastasis in the liver. These instances seem to show that the whole pancreas can be removed without seriously affecting the life of the patient, but the operation is one of great technical difficulty.

The results of partial resection for malignant disease are most unsatisfactory. This operation has been performed in 13 cases with 7 deaths. The patients who survive the operation usually die from recurrence of the tumor within a short time. These unfavorable results are due to the difficulty of making an early diagnosis.

If the tumor is so situated that a median incision is employed, the first care of the surgeon should be to expose the tumor itself and its relation to the stomach. If the stomach is situated low down, the tumor may be reached above its lesser curvature through the lesser omentum. In other cases a tumor is better exposed by dividing the gastrocolic ligament, and in still others the greater omentum and transverse colon may be raised up out of the way and the tumor reached through the transverse mesocolon.

When the tumor has been exposed in one of these ways, the question of its enucleation or the removal of a part or the whole of the pancreas must be decided. Enucleation is useless unless the tumor has a distinct capsule. Thus it is useless to enucleate carcinomatous nodules. The chief risk even during enucleation is from hemorrhage, for the pancreas is very full of vessels. Smaller vessels should be ligated, larger ones avoided as far as possible. The wound in the pancreas can be reduced in size by suture. Unless the control of hemorrhage is perfect the wound had better be tamponed.

If the tumor cannot be enucleated, the difficulties of operation are increased. Above all things, the surgeon should avoid wounding the portal vein or the vena cava. The splenic vessels may be ligated with safety, as the circulation of the spleen is also supplied through the branches of the gastric artery. Ligation of the superior mesenteric artery or its branches is followed by gangrene of the intestine. In separating the head of the pancreas from the duodenum which curves around it, the superior and inferior branches of the pancreaticoduodenal artery and the common bile-duct should be avoided. The latter often passes through a part of the pancreas.

Tumors of the tail of the pancreas are more easily removed, for the body of the organ often forms a sort of pedicle which can be ligated and divided. Tampons are best inserted in the form of a handkerchief dressing. In a few cases a tumor of the tail of the pancreas develops retroperitoneally toward the left, so that it is accessible through a lumbar incision.

In most cases of malignant tumor of the pancreas radical operation is not feasible on account of the late stage of the disease when the diagnosis is first made. There are two complications which may be relieved by a palliative operation. These are, jaundice due to pressure on the common duct, and stenosis of the duodenum. The evil effects of jaundice may be avoided by performing cholecystostomy, or by establishing a fistula between the gall-bladder and the small intestine. The former operation is simpler, but it leaves the patient during the rest of his life with an annoying biliary fistula. If an anastomosis is established between the gall-bladder and the intestine, the patient is saved from a biliary fistula, but is exposed to the risk of infection proceeding from the intestine into the biliary ducts. In most cases the jaundice is not an important complication, and it is only in exceptional instances that these operations for its relief are advisable.

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duodenum, the symptoms thereby produced may be sufficiently serious to make it advisable to perform gastro-enterostomy or jejunostomy. The former operation is preferable since the normal methods of nutrition are maintained, while a patient upon whom jejunostomy is performed will always be subjected to the annoyance of the introduction of nourishment through the fistula.

CALCULUS OF THE PANCREAS.

Calculi composed of calcium phosphate and carbonate may form in the pancreatic duct, presumably because the flow of secretion is obstructed. They set up inflammation of the parenchyma, which may go on to abscess formation or lead to a chronic dilatation of the pancreatic duct. Such a calculus may have produced attacks of colic similar to those due to a biliary calculus. It also produces disturbances of gastric and intestinal digestion, with resulting emaciation.

Glycosuria is a frequent symptom of calculus. Fatty stools are occasionally noticed. In some instances there is ptyalism. Pressure upon the common duct may produce jaundice.

The diagnosis cannot be made with certainty. In a few cases attacks of the character mentioned have been followed by the discharge of a calculus through the rectum, and in other cases pancreatic calculi have been removed from abscesses. The cases in which calculi have been removed from a pancreatic duct by operation are very few indeed. If a calculus is suspected at operation, the whole gland should be carefully palpated; and if a calculus is felt, it should be cut down upon by one of the methods described for cysts and tumors. In operations upon the bile-ducts, it is well to palpate the head of the pancreas in order to see if it contains a calculus. If a calculus is found in the main duct or one of its branches, it should be cut down upon through the substance of the gland and removed. If it is impacted in the papilla like a biliary calculus, it is most easily reached by opening the duodenum. If there is no acute inflammation around the calculus, the incision in the pancreas may be sutured. If suppuration exists, tamponade is preferable.

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